AUTOMATION

AUGUST 1959

Extending Process Control

WITH PNEUMATIC-ELECTRICAL TRANSDUCERS

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Cost Analysis and Machine Replacement
- Manufacture of Portland Cement
- Handling Broken-Lot Orders
- Evolving an Assembly Machine

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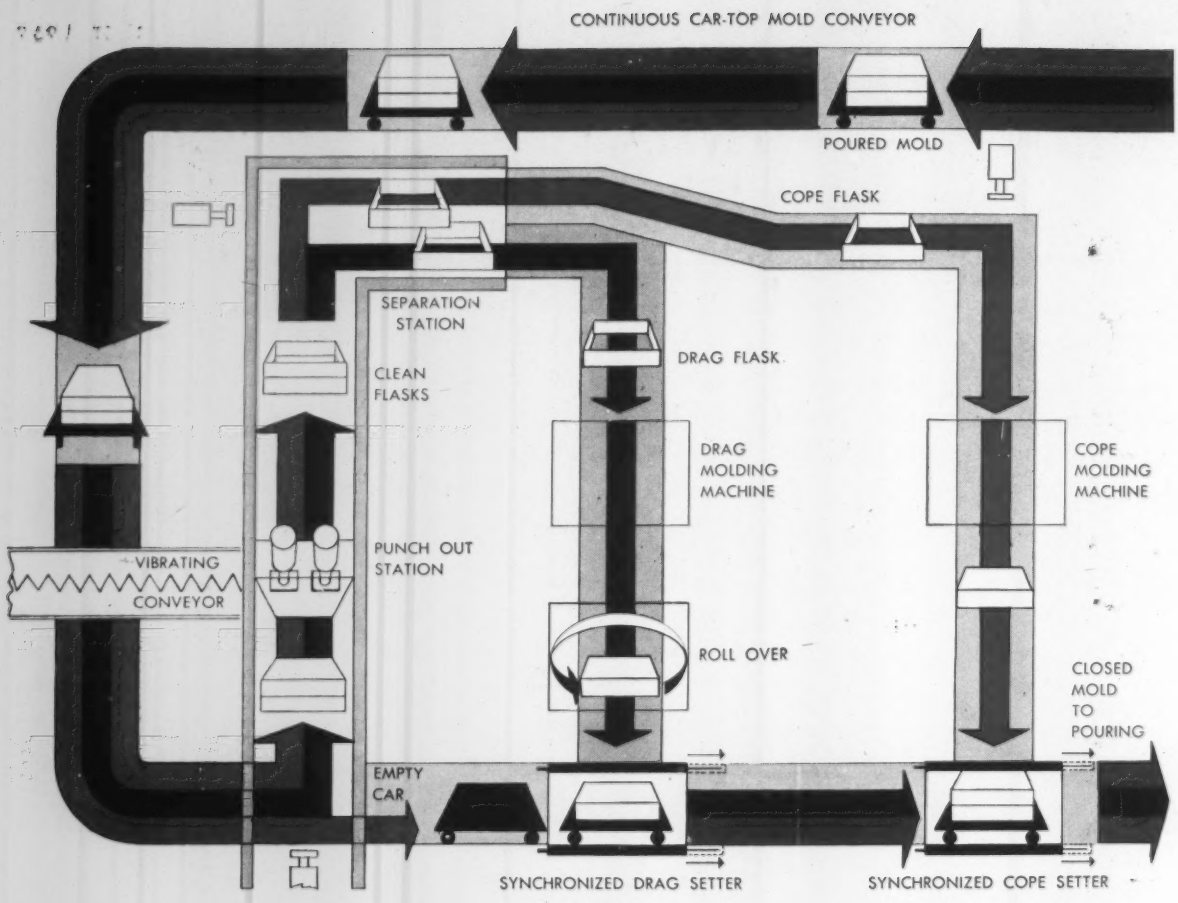
A PENTON PUBLICATION



NEW AUTOMATIC MOLD HANDLING SYSTEM

..ANOTHER EXAMPLE OF PLANET VERSATILITY

Custom designed systems, such as the automatic mold handling system shown in the above diagram, have helped build Planet Corporation's reputation throughout industry as a *versatile* organization . . . as an organization with solutions to the most perplexing production, materials handling and automation problems.

This system, installed in a large automotive foundry, automatically handles molds from start to finish. After molding, the drag and cope flasks are brought together and gently and accurately closed in position for pouring. Following pouring, the castings and sand are punched out, the clean flasks are separated and recirculated through the system . . . *a system which will pay for itself in less than one year.*

This is only one example of "PV" . . . *Planet Versatility.* Planet "PV" engineers have automated many types of production lines, built bulk and unit materials handling systems, designed complete plants, developed the world's only true universal transfer device . . . in fact, they are experts on all types of special handling and automation machinery, and materials handling equipment.

No matter what your problem . . . no matter how big or difficult your problem, "PV" will save your time in finding cost-saving, efficiency-increasing solutions. Let Planet demonstrate how its versatile engineering skill, and production and erection know-how can help you . . . you'll find *it pays to plan with Planet.*

PLANET CORPORATION

910

- Engineered Handling Systems
- Automation Equipment
- Mill & Foundry Handling Equipment

1810 SUNSET AVENUE
LANSING, MICHIGAN

Circle 651 on Page 19

Torch manufacturer "carries the torch" for big brawny bar automatic!

Growth of a company from the founder's first fond dream to a leading place in the industry is a matter of continuing product improvement, sound management, ever-increasing efficiency, keeping pace with changing times. Read what a line of machines named Greenlee means to a company named Turner . . . and why, out Sycamore-way, they "just love those Greenlee Bar Automatics" . . .

The Great Fire of 1871 struck and scarred Chicago the very same year that enterprising Edward S. Turner "hung out the shingle" at 4 LaSalle Avenue and proclaimed to one and all that The Turner Brass Works was ready for business.

It's a long way from the Horse Age to the Age of H-Power . . . 1871 to 1959. A whole way of living changed, new products came to the fore. Alert, trend-conscious Turner kept pace with the advancing times, moved the factory to Sycamore, Illinois in 1906 . . . expanded its operations steadily until today the Turner Corporation spans 100,000 square feet of factory space, and turns out products ranging from propane torches to plumbing fixture fittings—blow torches to diesel engine starting aids — camp cook-stoves and lanterns to furnaces and furniture hardware.

Along that route Turner continually met the old familiar problem: *How to get high-speed production and maintain top quality.*

That's where Greenlee enters the picture, and the Case of the Propane Torch is a typical example. It's a "How-They-Dunit" that may hold eye-opening suggestions for some of *your* production problems.

Turner's Propane Torch suddenly became a "hot" item — hot as its glowing tip. An expanding nation-wide need for it in home and shop at length blossomed into an enormous increase in demand. The order went out: "Turn 'em out faster — but keep quality up — keep cost in line." How to do it was the question.

Turner management launched an exhaustive investigation of top-rated production machines on the market. They probed, tested, ran trial runs. Eventually they found a machine that seemed to do everything they asked. It took 9/16" round brass stock, gave it a merry whirl — 298 surface feet per minute on stock diameter—2029 revolutions per minute.

Quality tested consistently high, rejects were held to a minimum, a complete operation was eliminated, as the husky Greenlee Bar Automatics "rolled 'em out" with the tireless gait of a 'round-the-clock marathoner.

That's when a long and happy association began. For shortly thereafter, the Turner P.A.'s signature was on a purchase order for a battery of Greenlee Automatics with special attachments.

A look at the Job Progress schedule will give you an idea of how efficiently they tick off a 6-stage operation on mixer tubes:

1st Position:
The big Greenlee Cam-Feed 1-5/8" Six-Spindle Bar Automatic uses a 1" tool slide stroke with .0063 inch feed on the endworking tools. Stock is fed out to length during indexing, spot-drilled, knurled (using a standard plunge-type knurl holder and a two-roll roller rest)

2nd Position:
The mixer tube is faced by a knee turner while a .277 inch diameter drill, mounted on a high-speed drilling attachment, drills to depth.

3rd Position:
Outside diameter is sized by a standard dovetail form tool. A .187 inch hole is drilled partway, as a two-roll roller rest supports the part.

4th Position:
Using a standard milling attachment mounted on the tool slide, the two parallel flats are milled. (Attachment consists of two milling cutters mounted on a keyed arbor in the milling head). Milling head rotates at the same r.p.m. as the workpiece; internal gearing in the attachment rotates the milling cutters at proper speed for the milling cut.

5th Position:
The .187 inch hole is drilled to depth while a standard cut-off tool breaks down for cut-off.

6th Position:
A 5/16" — 27 thread is tapped, and the part is cut off.

FINAL SCORE:

580 high-quality mixer tubes per hour at gross production rate. One complete operation eliminated. Rejects at an all-time low. . . . No wonder, out Sycamore-way, they "just love those Greenlee Bar Automatics" — big — brawny — and *bears for the jobs where you've got to keep your quality reputation as you keep up with market demand.*

Question:
Have *you* looked into Greenlee, lately, for quality on a production basis?

GREENLEE BROS. & CO.

GREENLEE

1867 Mason Avenue
Rockford, Illinois

Circle 654 on Page 19

How to avoid a common cause of machine downtime

Even well designed and engineered machines can turn out to be big headaches. Common cause: Downtime due to excessive maintenance of electric controls.

Electrically operated machinery is only as good as the controls which govern its operation. Minimum electrical maintenance means less machine downtime.

Hint: To insure maximum operating efficiency for *your* machinery, check the above photograph. It shows the contact tips (at right) from a Clark Type "CY" A-C Motor Starter after one year of continuous service with frequently as many as 5,000 operations per hour. Compare them with the new, unused tips at left above.

See for yourself that except for slight discoloration and minute pitting the used contact tips show very little evidence of wear even after one year of steady operation. Many more years of reliable, maintenance-free (and downtime-free) service are assured.

Clark's exclusive "arc quenching" principle, which works through the use of strong, multi-turn magnetic blowouts and double-break contacts, is the answer.

The action of the magnetic field not only forces the arc to rotate, moving it continually over contact surfaces, but tends to "quench" it at the same time. As a result, there's less wear on contact tips and a substantial reduction in maintenance requirements – much less machine downtime.

There are many more good reasons why the Clark Type "CY" Starters will control your machines better – help them to put their "best foot forward" and keep it there. For *all* the facts on Clark "CY" Starters, as well as space-saving "PM" Relays and other controls in Clark's "standard of quality" line contact your nearest Clark Controller sales office or distributor. Or, write direct.

9S2

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The CLARK CONTROLLER Company

Everything Under Control • 1146 E. 152nd St. • Cleveland 10, Ohio

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AUGUST 1959
Vol. 6 — No. 8

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Manufacturing Operations

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automation outlook

NEW COST PICTURE

". . . it is no longer realistic to consider automatic equipment only in terms of replacing the worker and returning the investment in six months or one year. Today the purchase of such equipment is approached from the viewpoint of productivity and quality. This change in attitude is stimulated by the pressures of competition and technological advance. The trend of progress of the whole industrial organization is accelerating. Each company's chances of keeping up, avoiding obsolescense, and maintaining a competitive position demands this whole new approach to economic cost analysis. . ."*Robert A. Lowe, managing partner, R. A. Lowe & Co., see page 46.*

KEY REQUISITE

". . . the main problem in automatic assembly is to obtain uniform parts . . . With machine assembly it is sometimes necessary to insert a parts inspection operation before assembly, as well as the customary inspection after each operation . . ."—*Robert Moore, president, Moore Equipment Co., see page 70.*

CONTROLLING PACKAGING COSTS

". . . we deal with products of high intrinsic value, and direct labor costs are often a relatively small cost of the finished product. Nevertheless, the opportunity for automation in increased productivity is always present, as attested by the fact that total employment in our packaging department over the last 5 years has decreased 13 per cent, while our sales have increased 62 per cent. This was accomplished by automating carefully and by paying close attention to package design so that our packages would lend themselves to good production techniques. . ."—*Foster B. Whitlock, president, Ortho Pharmaceutical Corp.*

METHODS REPLACEMENT

". . . to secure maximum savings we should consider changing our manufacturing methods rather than merely replacing individual machines. By the same token, the machine tool builder must critically question the function that his product serves for the customer. It is how well he recognizes the improved methods that his type of equipment can make possible that will largely determine his market participation in the future, rather than increased speed or size of his machine. . ."—*G. W. Jernstedt, mgr., Manufacturing Planning, Westinghouse Electric Corp.*

LONG-RECOGNIZED NEED

". . . we in the power industry today think of ultimate automation as the power plant with a pushbutton startup from the dispatcher's office—with a computer soon to replace the dispatcher. But, partial automation of complex component systems has been an established fact in this industry for a long time. Even when the power industry was an infant, its engineers were farsighted enough to see that automatic control of complex equipment, such as a boiler, was initially desirable and eventually a necessity. . ." —*William F. Crawford, vice president, Rockwell Mfg. Co.*

INCREASED TEMPO

". . . business as a whole will make larger capital expenditures in the next 5 or 6 years than in the past 25, and the rate of automation will have to be increased, let alone maintained, if we are to meet the future demands of this economy of ours. . ."—*D. G. Mitchell, chairman of the board, Sylvania Electric Products Inc.*

AUTOMATION

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BPA NBP

. . . Fluid Power news

REPORT No. 11,705 HOIST—TRAVERSE—CABLE REEL DRIVES

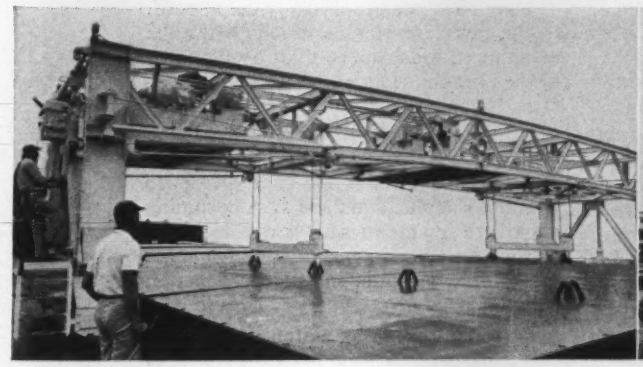
From Oilgear Application-Engineering Files

HOW OILGEAR DRIVES SPEED HANDLING OF ORE BOAT'S "KING SIZE" HATCH COVERS

OPERATOR: *M. A. Hanna Company . . . National Steel Corp., Owner. (Builder) — (The American Ship Building Co.)*

DATA: To speed loading and unloading, avoid damage to hatch coamings, reduce hold cleanup time . . . the 710-ft Great Lakes ore carrier *George M. Humphrey* was equipped with 17 x 54-ft hatch openings rather than standard 11 x 46-ft hatches. To lift, carry, and stack 19 of these larger, heavier hatch covers, a 59-ft span traversing crane weighing 24 tons was specially designed.

Crane Drive Requirements: 1. Traverse a 3° slope while lift-loading 30,000 lb (weight of hatch cover plus 5,000-lb ice allowance). 2. Lifting-lowering speed — infinitely variable, 0 to 20 ft/min. 3. Traverse speed — infinitely variable, 0 to 120 ft/min. 4. A separate, constant-torque cable reel drive to automatically "pay off" and retrieve crane power supply cable during 500-ft hatch deck traverse. 5. Smooth, dependable operation, precise speed control, controlled acceleration and deceleration, dynamic braking during continuous exposure to the elements, occasional exposure to iron ore and coal dust, over an 80° range of temperature, with minimum maintenance and power consumption.



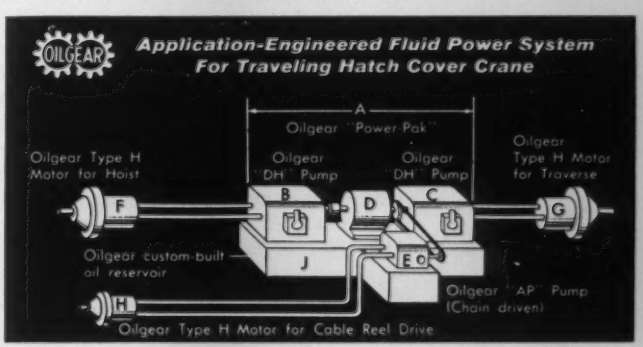
Control platform end of the double-truss hatch crane on ore carrier *George M. Humphrey*. Oilgear "*Power-Pak*" position is indicated. Oilgear *Fluid Power* hoist drive motor (F) can be seen in the center of the 59-ft span.

17-ft x 54-ft hatch covers being stacked in the 19-ft space over the hold bulkheads. Over-all crane height is 15 ft above the deck. Clearance is sufficient to stack 7 hatch covers. Oilgear *Fluid Power* traverse drive is visible to left.

SOLUTION: Three separate Oilgear "Any-Speed" Drives . . . one for the hoist, one for traversing, one for the automatic power cable reel. Controlled *Fluid Power* for each drive is generated by a single Oilgear custom-built "*Power-Pak*" (A). The "*Power-Pak*" consists of: 1 Two Oilgear type "DH," two-way, variable displacement pumps with integral, hydraulic servo-motor lever controls (B & C). Pumps are direct-connected to opposite ends of a double-end, constant-speed, AC motor (D). 2. An Oilgear type "AP" variable displacement pump with automatic, constant-torque control (E), which is chain-driven from motor (D). 3. A fully equipped oil reservoir (J), has all above equipment mounted and coupled for easy, single-unit installation on the hatch crane.

OPERATION: Oilgear type "DH" variable displacement pumps (B & C) supply controlled *Fluid Power* to Oilgear type "H" constant displacement motors (F & G). Motor "G" drives crane traverse wheels through reduction gears. Motor "F" powers the hoist. Integral pump controls provide both dynamic braking and acceleration and deceleration limitation to reduce peak loading. Chain-driven, Oilgear type "AP" variable displacement pump (E) with automatic, variable torque control supplies controlled *Fluid Power* to Oilgear type "H" motor (H) for the automatic, constant-torque power cable reel drive. Oilgear custom-built oil reservoir (J) serves as a base for the above pumps and controls completely mounted and coupled to the customer's electric motor (D). Oilgear single-unit "*Power-Paks*" are shipped complete — ready for installation . . . eliminate costly hand-fitted assemblies, unnecessary engineering, excessive power loss, leaks, repetitive malfunctioning, and "Christmas tree" appearance. Uses simple across-the-line starter — not complex DC controls.

USER REPORTS — *operation is fast, quiet, smooth . . . all hatch covers have been removed and stacked in a record time of 28 minutes.* Dependability and low maintenance are illustrated by the statement — *all equipment in excellent condition* — quoted from a routine service check report dated May, 1958 — after four years of operation . . . further confirmation of the statement heard in all industry — "*for the lowest cost per year . . . it's Oilgear!*"



In addition to Oilgear Hatch Crane drives, the "*Humphrey*" is equipped with a C. H. Wheeler electrohydraulic steering gear powered by two Oilgear type "DH-60" two-way, variable displacement pumps with integral servo controls. A few of the other Oilgear-equipped Great Lakes ships are the *Ernest T. Wier; Wilfred Sykes;* the "*Fords*" — *William Clay, Henry II, and Benson; E. J. Block;* tanker *Chicago Socony;* the "*Forts*" — *Henry,* and *York* . . . plus many other vessels of all descriptions operated on the navigable rivers, lakes, harbors, and oceans of the world. Other Oilgear marine applications include mobile drilling barges, elevators, catapults, hoists, winches, capstans, steering gear, large valve controls, and numerous lock and dam gate installations.

For practical solutions to YOUR linear or rotary drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

1598 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

Circle 656 on Page 19

Now available on all Parker-Hannifin

STRAIGHT THREADS FOR LEAK-PROOF

Industry's new standard as published in J. I. C. Recommendations (April, 1959) and S. A. E. Standards (1959 Handbook)

Why accept less?

Parker-Hannifin now offers a new standard *at no extra charge*—high-pressure hydraulic components with straight thread port connections* for O-ring type fittings. This new standard—assuring a leak-proof and drip-free seal—is the most logical engineering approach to the problem of hydraulic circuit connections. The Joint Industry Conference Recommendations now state:

"Fittings that incorporate separate synthetic or metal-to-metal seals, or seals that seal with pressure *should* be equipped with Unified National Fine (UNF) straight thread port connections."

And the Society of Automotive Engineers' 1959 Handbook states:

"The S.A.E. straight thread 'O'-ring boss is the preferred port for use in hydraulic devices."

Both support this new standard—and the U. S. Navy Bureau of Ships in MS16142 (SHIPS) has adopted the S.A.E. Straight Thread Boss Design as their straight thread standard for use in hydraulic and air systems in Naval ships. Such extensive support is understandable. The Parker-Hannifin straight thread port connections combine a built-in pressure sealing device with a rigid mechanical connection. This contrasts with the loose connection of a "backed-off" pipe thread and a relatively weak auxiliary sealing device.

Straight thread fittings and port connections are not a proprietary product or design. Although developed by Parker-Hannifin, they were immediately made available to the fluid power industry on a completely open basis.

They have been thoroughly field tested. In the severe service on mobile hydraulic equipment, today more than 6 out of 10 of the port connections are of the straight-thread type.

Now machinery builders and users alike are turning to this proved method of port sealing. Pipe threads for high-pressure hydraulic applications are fast becoming obsolete as more and more leading manufacturers recognize these advantages of straight threads in their production equipment:

No more wedging action with resulting distortion and breakage due to over-tightening . . .

No more messy pipe dope and the danger that it will infiltrate the hydraulic system . . .

No more leaks because of temperature changes or high shock conditions . . .

No more failures of costly auxiliary seals due to weak, imperfect threads that fit on thread run-out.

Why accept less? Next time you order high-pressure hydraulic components, specify Parker-Hannifin with straight thread port connections and fittings . . . you'll get leak-proof sealing—industry's recommended standard.

**Mobile equipment spool type control valves are all supplied with straight threads. Other components are still available with dry-seal pipe threads.*

HANNIFIN COMPANY
545 S. Wolf Road, Des Plaines, Illinois

Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue, Cleveland 12, Ohio

Parker SEAL COMPANY
10567 Jefferson Blvd., Culver City, California

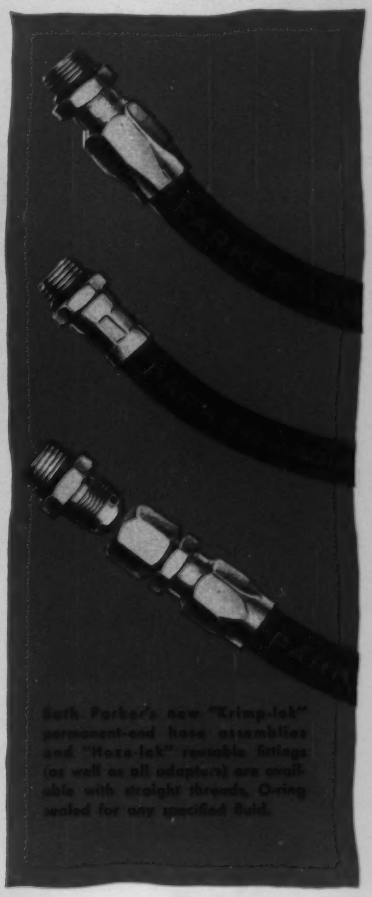
Parker HYDRAULICS DIVISION
17325 Euclid Avenue, Cleveland 12, Ohio

4 DIVISIONS OF PARKER-HANNIFIN CORPORATION

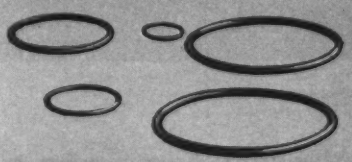
high-pressure hydraulic components

PORT CONNECTIONS...

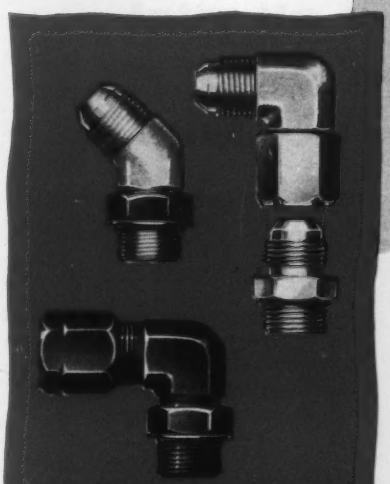
Specify straight thread O-ring bosses on your Hannifin high-pressure hydraulic cylinders for leak-proof connections at no extra charge. These port connections, together with Hannifin's drip-free rod seals, provide the answer to all your cylinder sealing problems.



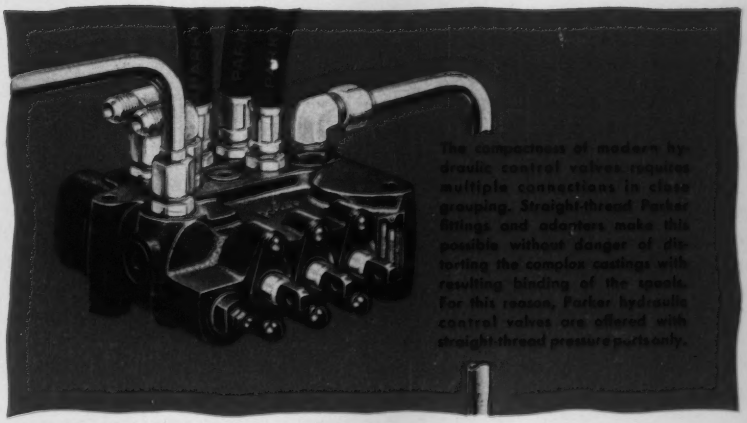
Both Parker's new "Krimp-lok" permanent-end hose assemblies and "Hose-lok" reusable fittings (as well as all adapters) are available with straight threads, O-ring sealed for any specified fluid.



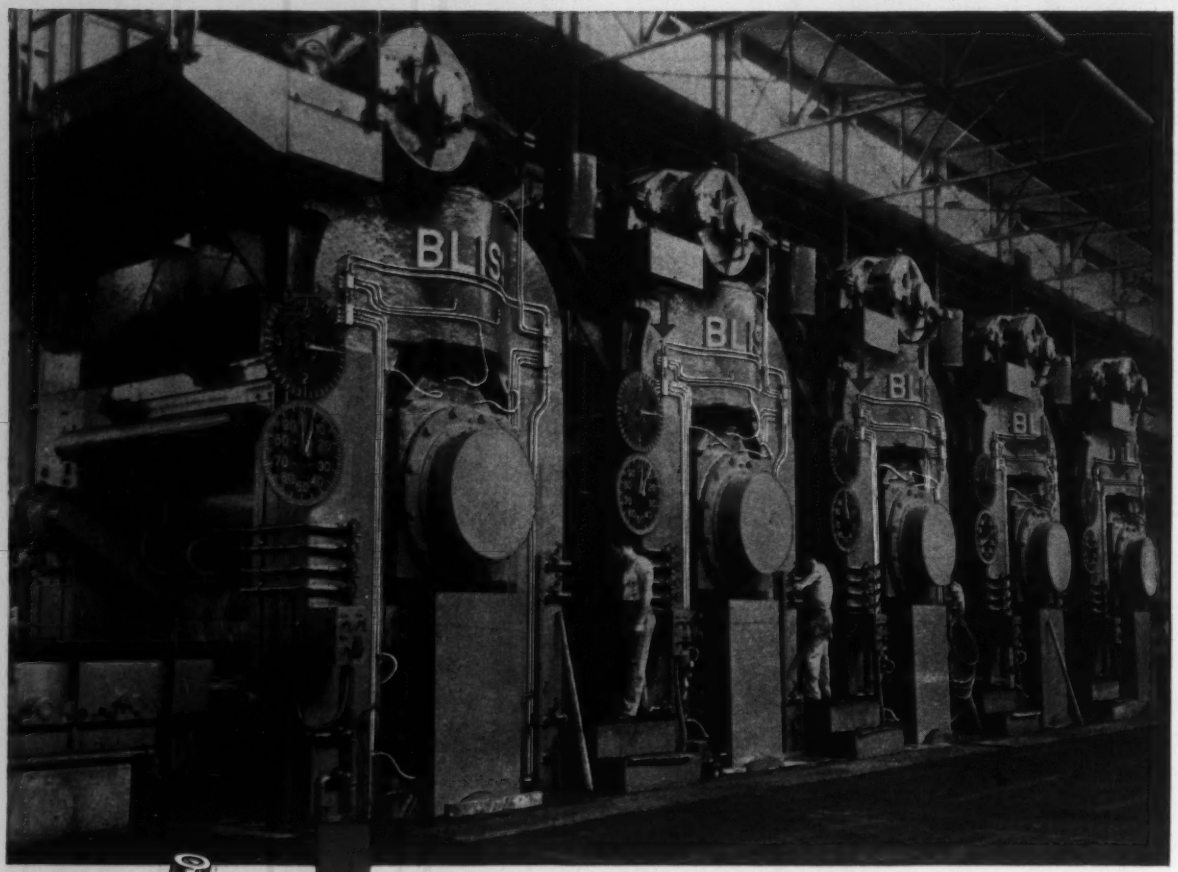
The O-rings used in Parker port connections are made only from service-tested Parker Seal Company compounds. With an ever-increasing number of fire-resistant fluids now on the market, it pays to avoid "jack-of-all-fluids" seals and stay with the Parker Seal compound specifically made for the fluid you will be using.

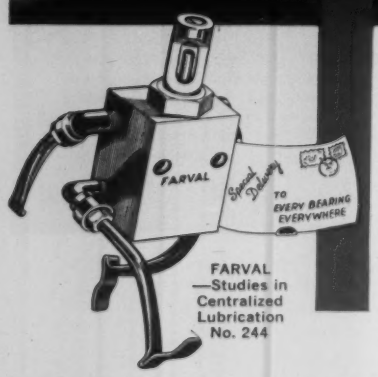


There's a complete line of Parker straight thread O-ring fittings and adapters for you to choose from... Triple-lok (flare type) and Ferulok® (flareless, bite-type). Either method assures you leak-proof, trouble-free hydraulic connections.



The compactness of modern hydraulic control valves requires multiple connections in close grouping. Straight-thread Parker fittings and adapters make this possible without danger of distorting the complex castings with resulting binding of the spools. For this reason, Parker hydraulic control valves are offered with straight-thread pressure ports only.





FARVAL
—Studies in Centralized Lubrication
No. 244

Farval protects all vital bearings on Bliss Non-Ferrous Hot Mill

When an up-to-the-minute rolling facility like this Bliss 80-inch, 4-high tandem hot mill is exposed to shut down due to bearing failure, weekly production dives, costs skyrocket.

So to eliminate possible failures of the mill's vital bearings, Bliss engineers installed an automatic Farval heavy-duty, time-clock controlled centralized lubrication system. It delivers proper amounts of lubricant — when required — while the mill rolls aluminum strip at 850 feet per minute.

Write today for your free copy of Bulletin 26-S. It gives all the facts on how centralized lubrication can profitably fit into your particular production picture.

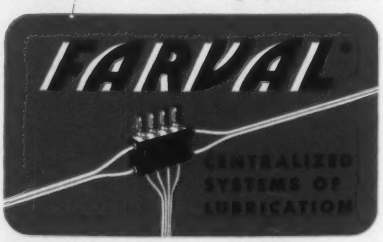
The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company
A subsidiary of Eaton Manufacturing Company

KEYS TO ADEQUATE LUBRICATION

Wherever you see the sign of Farval—familiar valve manifolds, dual lubricant lines and pump stations —you know rolling mill equipment is being properly lubricated.

® Reg. U. S. Pat. Off.



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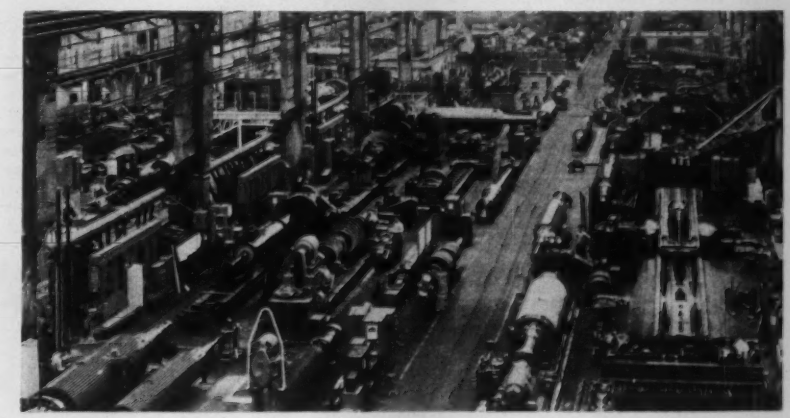
AUTOMATION news

Today's events and developments in the field of automation

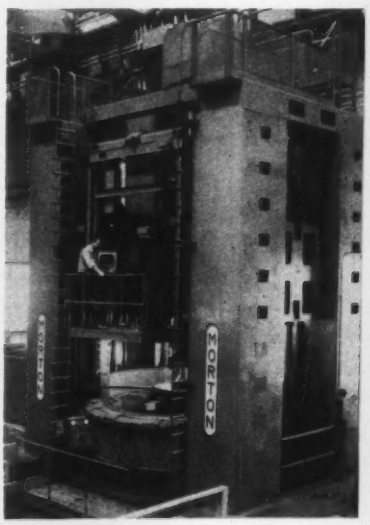
Numerically Controlled Machines Update General Electric Plant

DEMANDS for steam turbine-generators of ever increasing capacity, efficiency, and reliability over the last ten years have led General Electric Co. to continuously invest in new and improved manufacturing facilities. Culmination of this search for better ways of building larger turbine generators with ratings up to 500,000 kilowatts has resulted in a multimillion dollar array of automated machine tools at General Electric's Large Steam Turbine-Generator Dept. in Schenectady, N. Y.

Housed in a 23-acre manufacturing facility stretching more than 1300 feet in length, the department uses more than 1300 machine tools for the manufacture of over 5000 different turbine-generator components. Complicating the manufacturing operation is the fact that a large portion of the work is in small lots and special designs, many of which are never repeated. To overcome this production handicap, 6 of the 15 new machine tools recently placed in service are numerically controlled. This is in line with General Electric's growing emphasis on flexible automation, and more than 40 numerically controlled machine tools either have been installed or on order for use throughout the company's decentralized operating departments.



KNOWN as one of the largest job shops in the world, the Large Steam Turbine-Generator Dept. of General Electric Co. uses over 1½ million square feet of floor space to hold its more than 1300 machine tools. This view shows one of the six major manufacturing bays in the plant which builds steam turbine-generators with ratings from 50,000 to more than 500,000 kilowatts. A large percentage of the work is in small lots and special designs, many of which are never repeated.



CLOSED-CIRCUIT television system monitors the high-speed removal of metal from 20-ton turbine shells on this 4-story vertical boring machine built by Morton Mfg. Co. A General Electric numerical positioning system controls both vertical and radial tool position. The work table is 11 feet wide by 13 feet long, and any piece up to 10 feet high will clear the machine throat when the power operated table is traversed to work position. The operator rides an elevator during boring operations and views the cutting action of tools inside a shell by means of the television monitor.

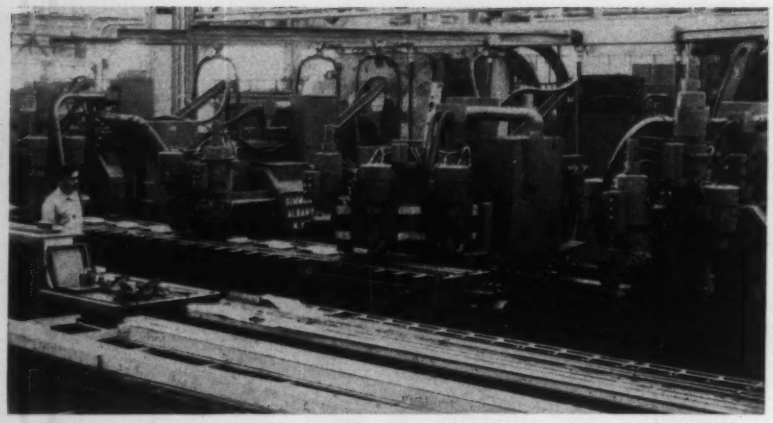
According to **H. R. Hill**, manager-manufacturing of the Large Steam Turbine-Generator Dept., the new machine tools are not merely newer models of the replaced equipment.

"Today, most manufacturing organizations have restrictive clauses in their union contracts. These clauses usually provide that established piece prices can be changed only by a change in manufacturing method, and the adjusted price must be in direct proportion to the change in allowed time for that part of the job affected by the newer method. This means that we must constantly work in the direction of new and substantially different equipment so that we have in reality a new job rather than a simple methods change."

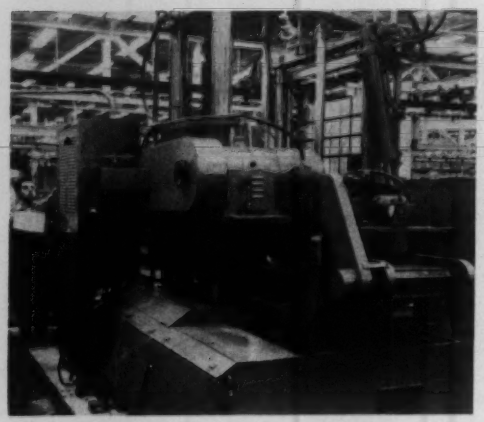
Mr. Hill also stressed the necessity for the utilization of more engineers in manufacturing today. "The Manufacturing Engineering component of our business has become increasingly important with the passing of time. We are continually looking for more and more engineers in the manufacturing phase of our business . . . Our turbine-generator productive capacity is increased so that we are now in a

position to meet the expected demands on us for several years to come This will require the highest talent of our development designing engineers. It will also require the fullest utilization of the talents of our manufacturing engineers and the automated machinery that they can apply to the job."

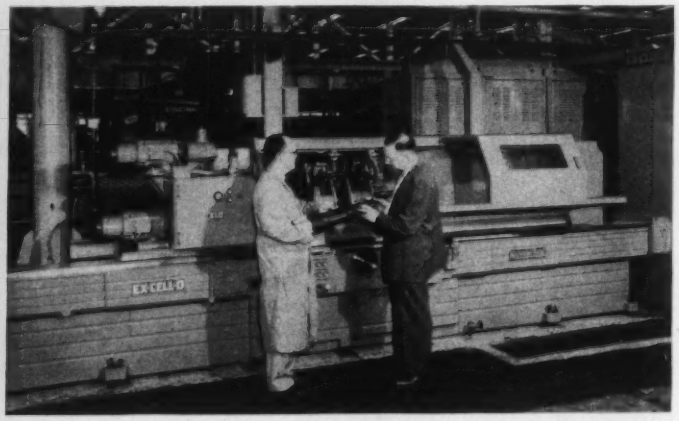
The accompanying photographs show five of the new tape or card controlled machine tools. Other more conventional new machines in the department are a Betts 16-inch horizontal bar machine, an Ingersoll 18.5-foot miller, an Ingersoll coil slotter, an Ingersoll automatic cutter-grinder, Hammond grinders, a Cincinnati automatic slab mill grinder, Giddings & Lewis vertical boring mills, Gray 8-inch horizontal boring mills, Cincinnati 6-spindle blade millers, and Consolidated-Betts special grooving lathes.



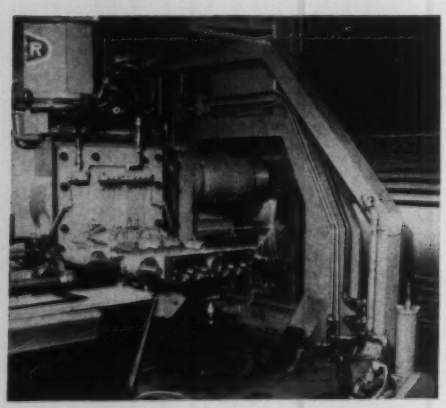
SIX HEADS on this Simmons Co. bar milling machine perform 250 operations under card control in machining hollow copper conductor bars for generators. Each bar averages 19 feet in length, is 1¾ inches wide, and has a 5/16 inch wall thickness. Both the rib section and cover section of the bars are machined at the same time, and, after machining, are brazed together to form a rectangular cooling channel. The first head wire brushes the surfaces to remove burrs, the second head feeds and welds 26 slugs for each bar for blocking passages, the third head cuts front side ports and back end tapers, the fourth and fifth heads make 45-degree cuts on both sides of the bar, and the last head deribs or widens the channel, makes the end cutoff, and prepares the bars for brazing.



NUMERICALLY CONTROLLED single-spindle horizontal drilling machine built by Walter P. Hill Inc. is used to drill tube sheets and tube supports for coolers used in generators. The machine drills 7/16-inch to 1½-inch holes in single plates as thin as ⅜ inch or in stacks as thick as 10 inches. Some plates require as few as 100 holes while other plates have as many as 1700 to 2000 holes. Drilling speed is 8 to 10 inches per minute, and carriage movement is 84 inches per minute or about 1½ seconds between holes.



FOUR of these numerically controlled profiling machines built by Ex-Cell-O Corp. will be used to mill contours on steam turbine buckets. This new type of miller does 3-dimension machining in a full circle around the buckets, preparing them for final grinding and polishing. The machine has a base mounted longitudinal table for the head stock and tail stock, between which the workpiece is chucked. Roller supports back up the workpiece against the thrust of the cutter. The cutter moves in and out to conform to the desired position as the workpiece traverses past it during successively indexed strokes. Continuous tool path information is provided by 1-inch wide magnetic tape through the machine's control system.



DRILLING, reaming, and milling as many as 2700 holes in rotors 24 feet long and weighing up to 90 tons is accomplished on this Baker Bros. Inc. tape controlled machine. The machine has a four-faced turret with each face having a removable head containing 5 spindles for drilling and reaming. A punched tape reader controls the machine in the desired sequence of tapping, drilling, or slot milling. For a detailed description of this machine, see AUTOMATION, Vol. 6, No. 5, May 1959, Pages 85-88.

MHI Schedules Regional Trade Shows For Next Two Years

AT THE CONCLUSION of the recent successful National Material Handling Exposition in Cleveland, the owner and sponsor of the show, The Material Handling Institute

You'll "Count your Blessings" in increased profits and production

when you count on Veeder-Root

Veeder-Root Counters on all production machines and processes will help you to:

Keep closer *Count*rol of manufacturing

Coordinate output of parts and components

Keep up to delivery dates

Keep closer *Count*rol of wage and incentive payments, piece work and payrolls

Avoid costly errors, waste, shortages

Anticipate maintenance needs

Veeder-Root makes all types of counters . . . manual, mechanical, electro-magnetic, electronic . . . to count anything at any speed. What do *you* need to count? We'll figure the way to do it.

You always "Know the score" when you count on Veeder-Root!

PANEL-MOUNTED ELECTRICAL COUNTER

Widely used for remote indication . . . can be grouped on panels in office. Speeds up to 1,000 counts per minute. Knob or lock-key reset. 6 figures. Also, base-mounted if desired.

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Circle 658 on Page 19

Inc., announced a new policy of sponsoring regional trade shows during the next two years rather than a single national exposition. Thinking behind this changed concept is that it is better to take the products to the market rather than require the markets to come to the products.

Under the regional show concept, the MHI will own, sponsor, and produce at least four—and not more than six—industrial material handling equipment shows in the next two years. The first show will be held in Boston during June, 1960, and will be known as the MHI New England Show. In November of 1960 a second regional show will be held at Louisville, Ky., and serve the central states area. In 1961 two shows have been scheduled—a Pacific Coast Show in San Francisco and an Eastern States Show in Philadelphia.

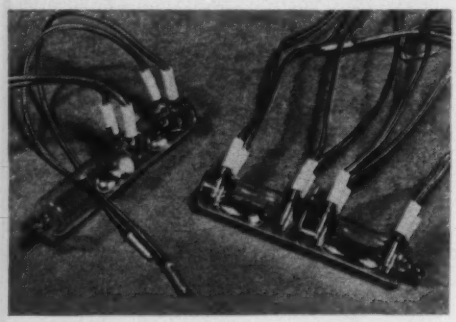
No decision regarding a future national exposition will be made until experience has been gained from the regional show program. The Material Handling Institute feels that the new policy will present the latest in handling equipment to the maximum customer audience, at the lowest possible display expense to the exhibitors, with minimum travel costs for potential buyers.

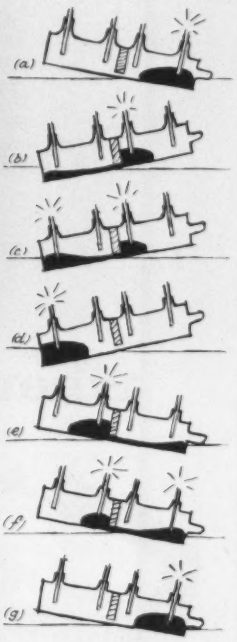
Flaws Detected And Thickness Measured With Ultrasonic Tester

ULTRASONIC test instrument which uses the pulse-echo detection principle for either flaw detection or thickness measurement has been announced by Branson Instruments Inc. Ultrasonic pulses are sent intermittently into a material under test and, together with the returning "echo," are displayed on a cathode-ray tube. Variations in the normal displayed pattern indicate a flaw or discontinuity.

The instrument can be used both for contact work and for immersion work. It has a broad-band amplifier which permits a continuous range of test frequencies from 0.4 to 10 megacycles. Transducers are equipped with quick disconnects for fast changing of test frequencies. Readout of results is on a conventional 5-inch cathode-ray tube showing an equivalent depth in steel of 1 inch to 40 feet across the 4-inch effective sweep of the tube. Instead of a square marker, the test pattern shows a pyramid which makes weak signals, or those at critical points, much easier to detect.

At 2.25 or 5 megacycles, using either contact or immersion transducer, an aluminum test block with a 1/64-inch flat hole in the bottom will cause a full scale signal. Flaws $\frac{1}{8}$ inch or more away from the surface are readily detectable. An optional plug-in flaw alarm will activate bells, relays, or other devices to signal that allowable test limits have been exceeded.





UNUSUAL mercury switch which controls the flow of mercury between contacts has been developed by American Designed Components Inc. Sketch shows operation of switch through one complete cycle. In initial position (a) pool of mercury makes circuit through extreme right contacts. As switch is tilted in opposite direction, mercury pool moves against a center plate containing a small orifice, making circuit through contacts to right of plate (b). Mercury flows through orifice in small stream, bypassing contacts to left of plate, and makes circuit through contacts at extreme left (c). As mercury fills left chamber, circuit through contacts to right of plate is broken (d). When switch is tilted in oposite direction (e), a similar sequence occurs except contacts to left of plate are energized while contacts to right of plate are bypassed (f, g). The company offers various circuit arrangements by adding or deleting contact electrodes.

NEMA Forms Group To Develop Automatic Systems Standards

RAPIDLY expanding markets and industrial processes of increasing complexity have led electrical manufacturers to recognize a need for standards for industrial control systems. Accordingly, the National Electrical Manufacturers Association (NEMA) has formed an Industrial Automatic Systems Section to establish standards in the areas of numerical control, computer control, and the more sophisticated analog systems.

The Section is composed of ten companies and is headed by **D. L. Pierce**, assistant manager, Control Dept., Motor and Control Div., Westinghouse Electric Corp. Within the Section, a General Engineering Committee has been formed to study definitions of automation systems and components and to establish standards of compatibility for components used in systems. A committee task group will review all existing and proposed definitions concerning automation systems and components that have been formulated by organizations other than NEMA and ASA.

Another committee task group will investigate the use of components in industrial automatic systems and devise standards for component service life; continuity of service or reliability; spacing for components in low voltage systems such as 15, 30, and 60 volts; and environmental conditions. It is not intended that the Systems Section develop standards for components themselves, but, rather, to recommend to other NEMA sections special requirements imposed on the

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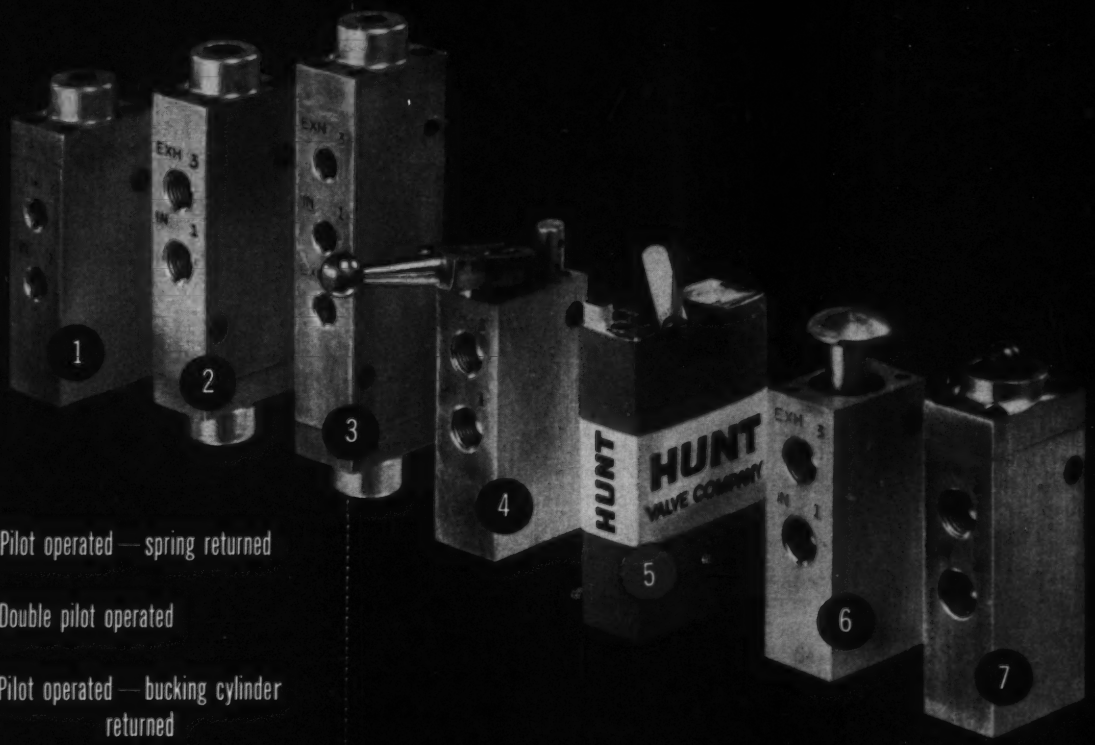
another

new valve

by **HUNT**

the **TRIM LINE**



1. Pilot operated — spring returned
2. Double pilot operated
3. Pilot operated — bucking cylinder returned
4. Lever operated
5. Reserved for valve actions to come
6. Palm-button operated
7. Ball actuated

An unbelievably small valve with a long, long life

Priced economically . . . that's TRIM LINE, Hunt's newest valve in a series of new valve designs.

The TRIM LINE is available in 3-way and 4-way actions. Furnished tapped for either ⅛" or ¼" pipe connections.

Designed for installations where space is limited, TRIM LINE is a quality valve you can depend on to work right . . . and to LAST. Just replace the "O" rings and it works on and on and on.

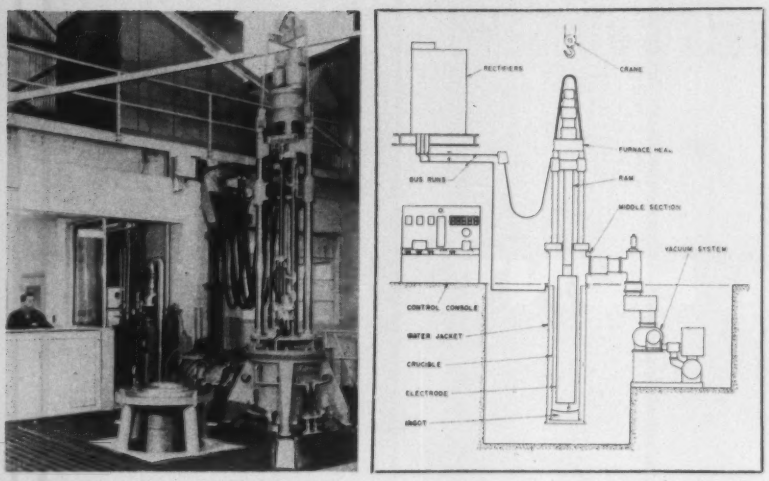
For complete details write to . . .

HUNT VALVE COMPANY • SALEM, OHIO, U.S.A.

HUNT *Quick-As-Wink* AIR & HYDRAULIC CONTROL VALVES

components by their use in a system.

Top priority has been given to establishing utilization standards for the following components: Card and tape readers, key punchers, typewriters for readout systems, position sensing devices, neon lamps, ac servomotors, synchros, and tachometers. Of equal importance are card and tape standards denoting such things as tape widths, card sizes, codes, number of rows of holes, etc. The IAS Section expects that some standards will be forthcoming in printed form by the end of the year.



CONSUMABLE electrode vacuum arc melting furnace built by Lectromelt Div., McGraw-Edison Co. has been installed at the Latrobe Steel Co. for the production of high purity steels. In the melting process, an air melted electrode of the desired steel alloy is suspended in a water-cooled copper crucible of the furnace. A low-voltage, low-amperage arc is struck; and, as the amperage is increased, the electrode melts. Inclusions such as oxides are removed by reaction in the arc, and dissolved gases in the steel are drawn off under vacuum. As the molten alloy continuously solidifies from bottom to top in the crucible, other undesirable nonmetallic inclusions float to the top and are removed by the arc reaction. The result is an ingot with an exceptionally sound internal structure, possessing workability and mechanical properties superior to those obtainable by conventional melting procedures.

International Flavor Included In ISA Instrumentation Show

CONFERENCES and exhibits have become traditional with the Instrument Society of America. This year their big one will be the 14th Annual Instrument-Automation Conference and Exhibit which will be held in Chicago, September 20-25. It is expected to draw a record attendance of scientists and engineers to participate in more than 30 technical sessions and to see displays by nearly 400 exhibitors.

Theme for the September conference will be, "World Progress in Instrumentation." In line with this objective, arrangements have been made to include presentations by foreign authorities in the field of instrumentation. Since the International Federation of Automatic Control is holding its General Assembly in the week preceding the ISA show, delegates to this meeting will have the opportunity of participating in the instrument-automation conference.

Special sessions at the conference will discuss instrumentation problems of major significance to management. Included in the papers to be presented at these sessions will be discussions of the economic justification for instrumentation of major operations in the railroad and cement manufacturing industries, how to organize for tomorrow's instrumentation in terms of experience in research laboratories of an automobile manufacturer, and special personnel training needs created by instrumentation.

A new technical division on photographic instrumentation recently formed by ISA will hold two sessions on photo instrumentation. These will include papers on the use of the photographic method for flight measurements in the aircraft industry, camera techniques in a radiation laboratory, photo instrumentation in the automobile and propulsion industries, and a survey of high-precision film readers with automatic output.

Other areas of instrumentation to be covered in the technical sessions include computer control and food processing. At least seven program events will emphasize the use of computers for running industrial processes. An all-day session is scheduled to discuss the present and future status of instrumentation in the food processing industry.

Magnesium Control Panels

LIGHTWEIGHT control panel boards made from magnesium sheet are offered by Panellit Inc. The panels can be faced on one or both sides with 1/16 inch Formica or Mylar as required.

In addition to being lighter in weight than steel, the magnesium panels permit savings in time, effort, and cost when installing additional instruments or making other panel changes in the field. The need for blowtorch cutting or welding during alterations is eliminated, providing for greater safety in hazardous atmospheres.

Manufacturer Stresses Uses Of Counters In Automatic Systems

MACHINES and production facilities that will keep track of their own output, check quality, compute effectiveness of performance, relay the data to a centralized control office, and even automatically shut down if something is amiss have been predicted by **A. E. Kallinich**, vice president of Veeder-Root Inc.

As an example, Mr. Kallinich stated that one highly automated production facility in a fluorescent tube plant is very nearly at this stage of sophistication. Each production line is comprised of groups of machines that perform such functions as inserting grid plates and filaments, sealing off the glass envelopes, evacuating the tubes, and mounting the bases. At the end of each line, the tubes are inspected and either passed or rejected, de-

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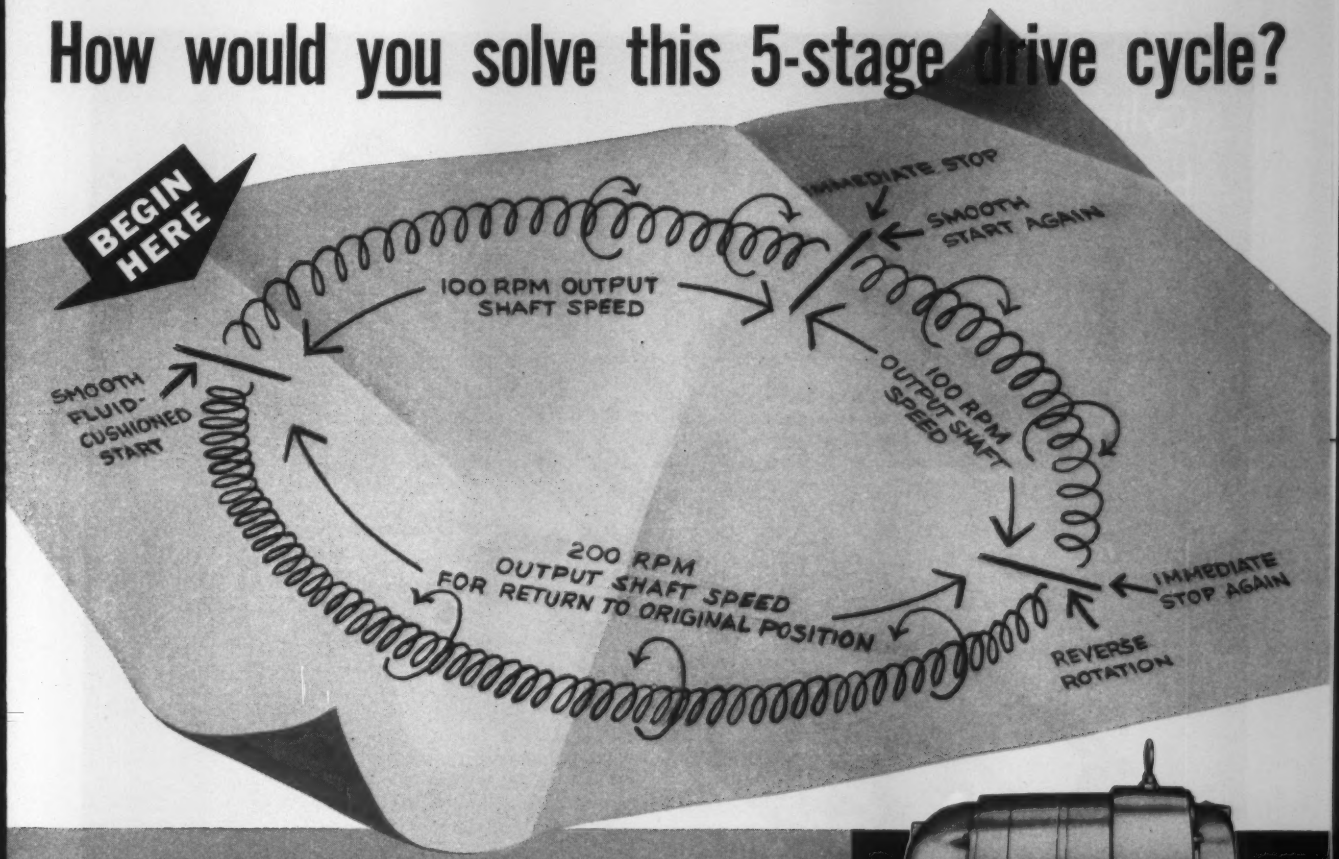
How would you solve this 5-stage drive cycle?

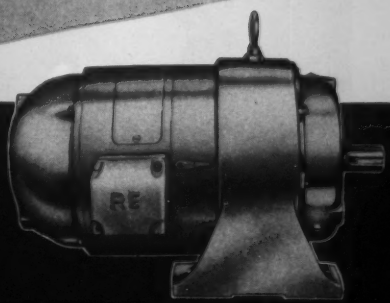


This one *modern* Reuland power package *does* all five!

Today's ingenous, automatic machines have demanded a whole new concept in electric motors. No longer will "just any motor do" because the motor now becomes merely an integral part of the modern drive *package*.

Reuland's "Xpandable Design" idea *originated* this modern new approach several years ago. With this unique system, drives incorporating many varied factors are supplied as a single unit . . . *tailored to the needs of each individual customer.*

Modern Reuland Power demonstrates every day that there *is* something new in electric motors. Whether *your* own drive needs are more complicated, or less, than the above sketch . . . it will pay you to take stock and compare with what Reuland can offer.



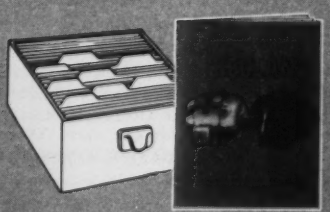
MODERN REULAND POWER

This unit contains an internal fluid coupling . . . a two-speed reversing duty motor . . . gear reducer . . . and magnetic brake mounted between the reducer and the fluid coupling. It is typical of the literally hundreds and hundreds of tailored adaptations available as a result of Reuland's modern "Xpandable Design" idea.

It is easy to see how this one, compact drive package saves costs and space and weight in comparison to installing separate drive units.

Our New General Catalog Will Come In Handy — Sent FREE On Request

Gives details on Reuland's "Xpandable Design" . . . also shows how O.E.M.'s save money by using Reuland's free "Special Motor Library." Get a copy for your files now, for sure.



MODERN POWER FOR MODERN-DAY PRODUCTS

REULAND MOTORS

REULAND ELECTRIC COMPANY

WESTERN DIVISION: Alhambra, California
EASTERN DIVISION: Howell, Michigan
DISTRIBUTORS IN ALL PRINCIPAL CITIES

® REGISTERED TRADEMARK

With Extras . . . At No Extra Cost

1. METAL PISTON ROD SCRAPER—protects rod packing, cylinder bore and rod surface by removing all foreign particles.
2. NEW "SUPER" CUSHION for air or METALLIC SELF-ALIGNING MASTER CUSHION for oil.
3. HARD CHROME PLATED CYLINDER BORES AND PISTON RODS for greater protection and reduced wear.
4. ONE PIECE PISTON assures better alignment, longer bearing and packing life.
5. FORGED SOLID STEEL HEADS throughout entire line.
6. PILOTED PACKING GLAND with extra long bearing for additional strength and support to piston rod.
7. NO TIE-RODS TO STRETCH—gives you 360° port rotation . . . less space used . . . full strength.
8. STREAMLINED DESIGN . . . operating pressures to 200 PSI, air; 1,000 PSI oil, non-shock.

Specify the

T-J Spacemaker

for longer, more efficient cylinder service

You too—can reduce replacement expenditures—lower maintenance costs with the T-J Spacemaker cylinder line. Designed and engineered for ruggedness, and accuracy of operation, the Spacemaker assures longer, uninterrupted operation.

The T-J Spacemaker eliminates tie-rods, gives greater strength, saves space . . . and reduces costs in all push-pull operations. Immediate delivery in a complete range of styles and capacities . . . air or oil. Write for Bulletin SM 155-4, today. The Tomkins-Johnson Company, Jackson, Michigan.

T-J TOMKINS-JOHNSON
RIVITORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

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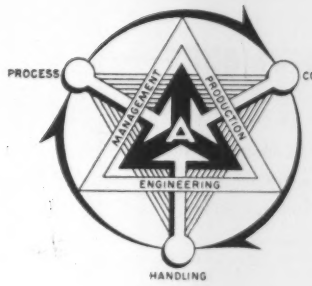

around the triangle

NUMERICAL CONTROL SPREADS TO INSPECTION

To prevent inspection bottlenecks, gaging and gage data processing operations for complex shapes can be speeded up with a new numerically controlled gaging machine developed by Pratt & Whitney Co. Inc. Known as the Data-Limit 6 Co-ordinate Measuring Machine, the instrument has 2 gaging arms. Each arm is capable of horizontal and vertical movement plus rotary motion around the X and Z co-ordinates. Input data on punched tape is used to move a gaging arm and head to a reference point on the workpiece. Operating under tape control, the gage head is then automatically positioned at a series of desired points in space. At each of these points, the gage head measures the deviation of the workpiece surface from its nominal location. Over-all gaging accuracy is 0.000150 inch with a repeatability of 0.000050 inch.

PROTECTS AGAINST RANDOM HOT SPOTS

Need thermal protection at an infinite number of points over a length of several hundred feet? Fenwal Inc. has developed a Line Temperature Dectector which is in the form of a small tubing that is responsive to thermal conditions over its entire length. When temperature at any point along the tubing reaches a set point, a short circuit occurs at that point, and a control unit is actuated. The detection tubing may be bent to practically any configuration, and standard elements may be connected in series to form lengths of several hundred feet. Within the over-all length, several different temperatures can be detected. Tubing is available with temperature ratings of 255, 310, 400, 575, 765, 900, 1050, and 1200F.

FASTER REBOUND FOR BOGUS CHECKS

An extra dividend for bank automation is that it will speed the bounce of rubber checks. According to the Office Equipment Manufacturers Institute, magnetically coded checks will give depositors less time to cover checks they cash out of town against insufficient funds in home banks. Last year more than 10 billion individual checks (good ones, that is) were written, and the total will grow by another billion checks this year.

INSTRUMENT MANUFACTURERS AFFILIATE WITH NEMA

Manufacturers of electrical indicating instruments—panels, switchboard, and portable—have affiliated with the National Electrical Manufacturers Association as a new NEMA industry section. Chairman of the new section is W. H. Steinkamp, vice president, Daystrom Inc. who will be assisted by vice chairman J. R. Whiteside, president, Simpson Electric Co.

STRETCH WIRE TAKES VIBRATION AND SHOCK IN STRIDE

It looks like any other parallel pair wire that is found in the home connecting lamps to electrical outlets. However, when tension is applied to the wire, it stretches up to 250 per cent of its original length. When released, the neoprene insulated wire snaps back to its original length. Developed by Stretch Wire Corp., the new wire is designed for any application up to 75 watts, is insulated to withstand 1000 volts, has a resistance of 0.15 ohms per extended foot, and has withstood better than 150,000 flexing cycles without breakdown.

BUILDS INTEGRATED COATING MACHINE

One of the largest pressure-sensitive coating machines ever built—capable of handling a web of material over 5 feet wide—has been designed. erected, and installed by New Rochelle Coating Corp. in its plant at New Rochelle, N. Y. In a single continuous operation, the 80 foot long machine applies an adhesive coating, and then dries, laminates, slits, and winds the web. Volume quantities of vinyl, acetate, oilcloth, oilsilk, Mylar, polyurethane foam and film, metal foil, and paper can be processed on the machine.

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438	478	518	558	598	638	678	718	758	798	838
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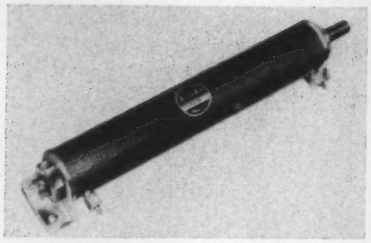


ACCESSORIES for a line of air cylinders manufactured by Allenair Corp. include two unique items. One is a hardened pin, shown above, which can be provided at either end of a cylinder to operate an electric switch or button valve controlling other equipment in synchronization with the stroke of the piston rod. The second is a bleeder valve, mounted similarly as the pin, which can be used to bleed air from other equipment as the piston reaches the end of its stroke. Both accessories are actuated by a cam-boss mounted on the piston rod.

pending upon quality.

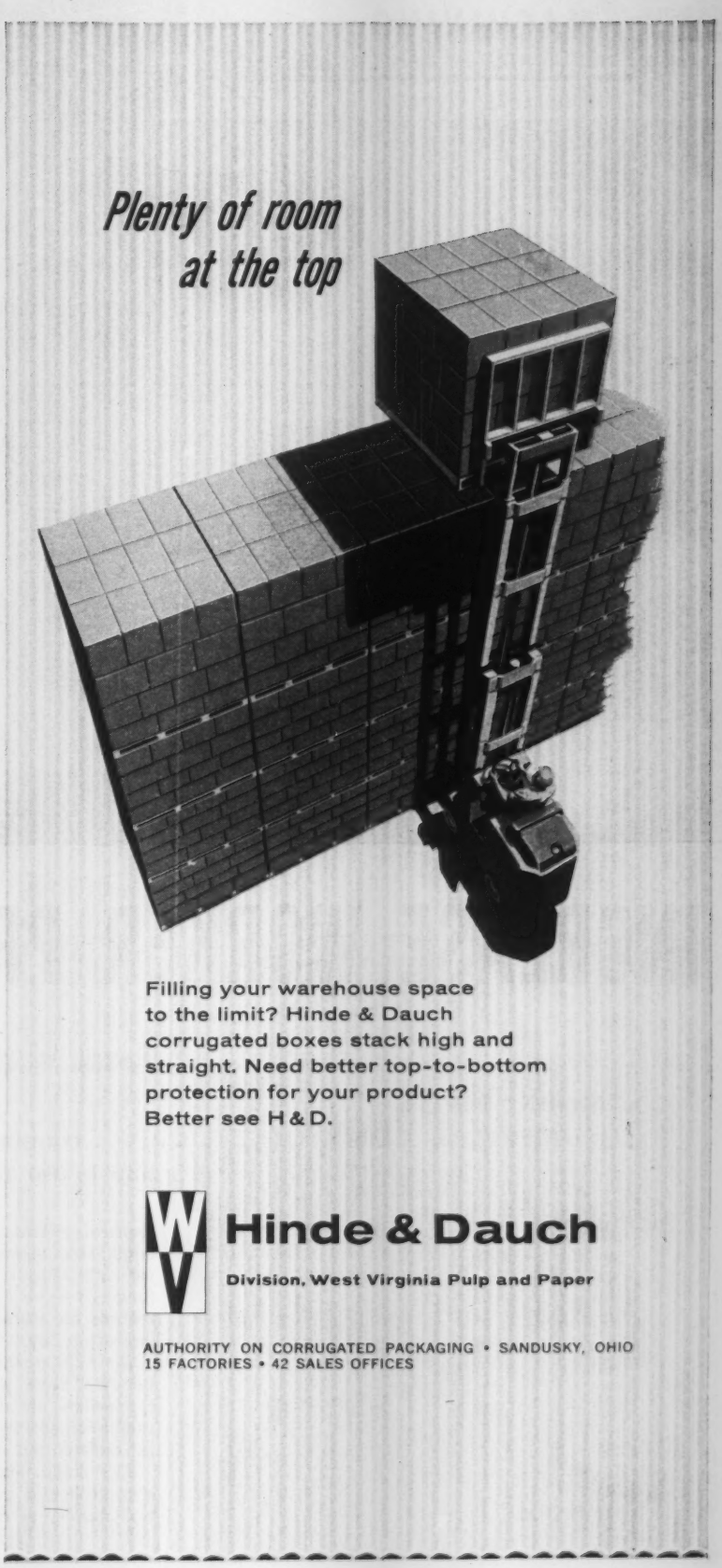
Rejected tubes are sorted by defect and passed down chutes where they are counted as they pass. At 20-minute intervals, predetermining counters compare the rejects for each cause with predetermined maximums. If any total exceeds the quality limits, the counter emits a signal that shuts down the line.

In addition, the rejects for all causes are also used as control standards. Finally, the accepted and rejected totals are automatically transmitted to an automatic production recording system that records data from each line and provides a printed record of output.

"Systems such as this are entirely within the means of the small shop," Mr. Kallinich continued. "The cost of the components is nominal, and the mechanical and electrical connections are relatively simple. They can be applied with equal facility to single machines or entire production areas."

Among the new developments that are certain to lead to even more advanced forms of computation, metering, control, and other functions are bulk flow, data readout, and electronic counters. Bulk flow counters are designed for use with a flow meter of the positive displacement or indirect type. Newest in the Veeder-Root line of bulk flow counters is one that will indicate rates up to 40,000 barrels/hour with extremely close accuracy.

Data readout models are standard counters to which have been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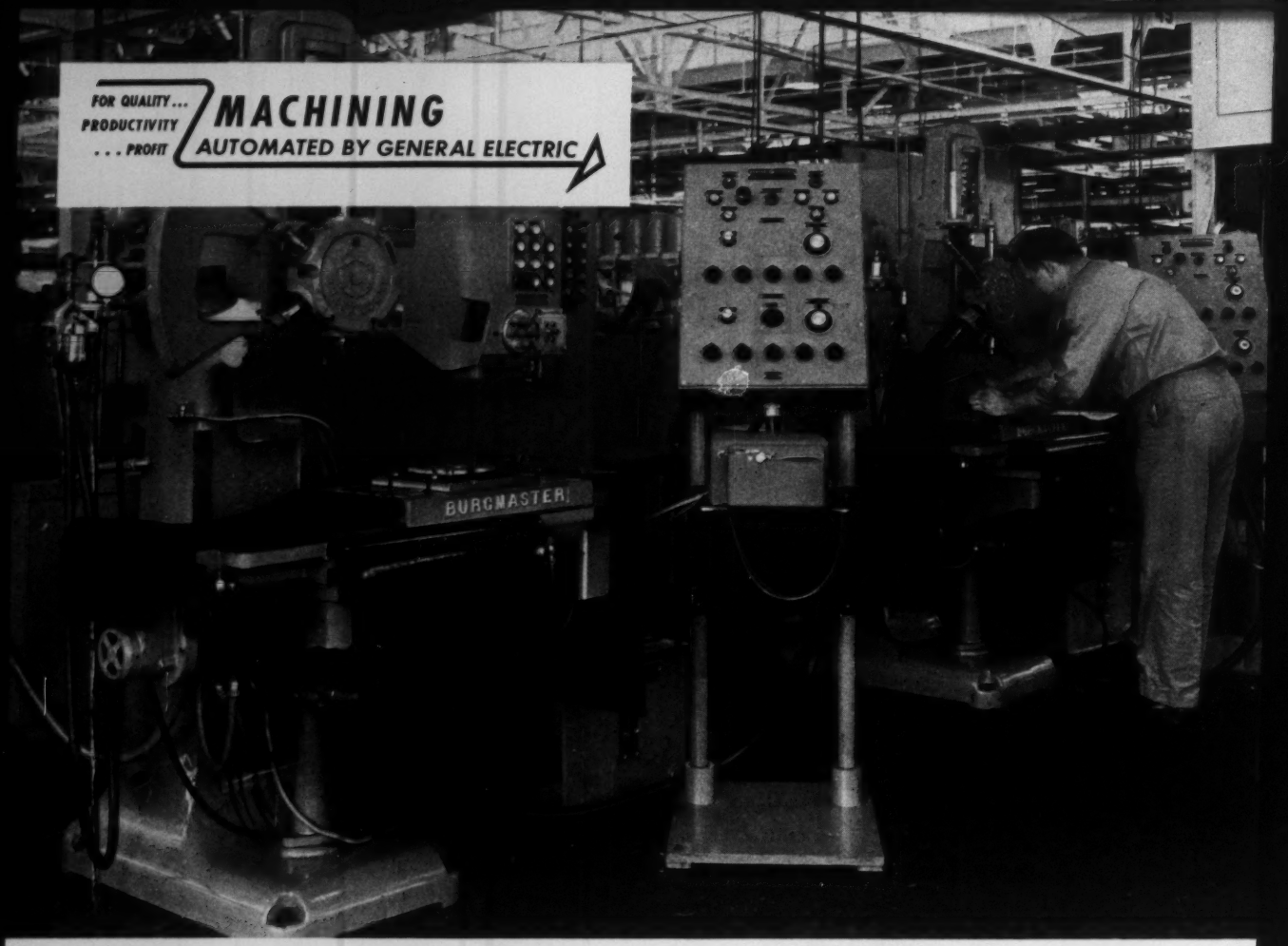

INCREASE WORKER PRODUCTIVITY

MARK SERIES NUMERICAL CONTROLS...

.....standard, job-proved packages now in use on a wide variety of machines

General Electric's Mark series of standard, pre-engineered numerical control packages—with systems for controlling 1 to 5 motions plus machine auxiliary functions — are compiling impressive performance records on scores of machines throughout American industry today.

Machine operation is completely automatic—from punched tape prepared on a standard automatic typewriter. If desired, semi-automatic positioning, useful for prototype work, is obtained with manually set dials on the control station.

Key components of a typical Mark package are a controller, a punched tape reader, operator's control station, servo drives and position-sensing units.

8-TO-1 TIME REDUCTION in press operations is achieved on this 100-ton rotary-turret punch press directed by General Electric numerical control. Rapid positioning of table and turret provides up to 40 punches per minute.

40% AVERAGE TIME REDUCTION for all parts produced on this horizontal boring machine means greater output and better equipment utilization. Lead times are cut by 8-to-1, and non-productive worker time is reduced by more than 60%.

with General Electric numerical control

Boost output of man and machine, reduce in-process inventory

Over the past 7 years, management has seen labor costs increase by 50% with productivity up by only 15%. This profit-cutting gap has accelerated an industry-wide need for production methods such as General Electric numerical control.

Key benefits of G-E numerically controlled machines include increased worker output, increased machine utilization, and reduced in-process inventory in virtually every job.

Manufacturers are now realizing far greater output per man-hour . . . faster "pay-back" rates on machines . . . shorter production cycles . . . and much lower inventory investment—in itself justification for numerical control. Here's an example:

Automatically controlled turret drills are used to produce aircraft-engine accessories at Chandler Evans Corporation, West Hartford, Conn. With numerical control, direct-labor costs have been cut in half! The machine operator—working two machines simultaneously—loads the piece, sets the machine in operation, and all production is performed automatically. But, increased productivity is only part of the story. Scrap losses are virtually eliminated, average lead times are cut by 6-to-1, cutting-tool costs are 1/40th of former production methods, and tool life is increased from 30 to 1300 pieces per tool—all adding up to expected *annual* savings of $42,000, more than enough to pay for both machines within two years.

Join with Chandler Evans and hundreds of other manufacturers who are increasing productivity, gaining better product quality, and eliminating tooling cost with G-E numerically controlled machines. See your G-E Apparatus Sales Engineer or machinery builder today. General Electric Co., Specialty Control Dept., Waynesboro, Va. 795-7

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 663 on Page 19

The NEW Series BH100

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1/10 THE SIZE...

10 TIMES THE ACCURACY
OF STANDARD INSTRUMENTS!

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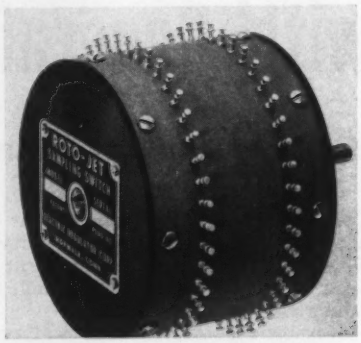
added 10-position contacts that provide a means of transmitting the counter reading electrically as well as visually. These readings can be fed directly into a card or tape punch or any other type of data handling equipment. This feature permits them to automatically process machine product, shaft rotation, or any other information that can be counted.

The most advanced class of counting devices are electronic counters. Standard production models for in-plant use are capable of rates of counts of 5000 units per second, and laboratory models have much higher ratings. Developed for high speed packaging and production lines, they also are invaluable when the counter cannot come into physical contact with the object, when the object has insufficient mass to actuate a mechanical counter, when an object passes the counter on a random path, and when the speed of the object is extremely high although the counting rate can be slow.

New Dies Boost Production

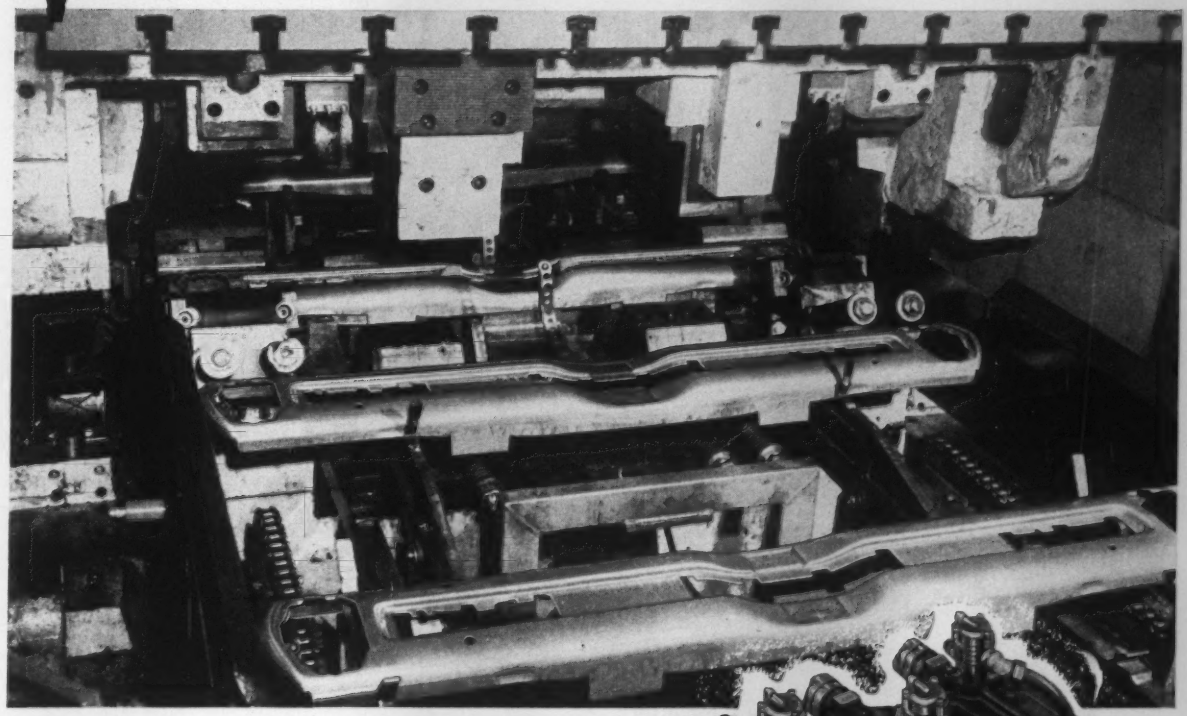
CHANGING from steel to carbide punches and dies has increased press production on 0.28 inch thick



SEQUENTIAL sampling switch capable of making more than 3600 closures per second has been developed by Electric Regulator Corp. Up to 45 contact pairs are positioned inside a cylindrical enclosure, and each pair is opened and closed by a rotating jet of air directed at the contacts. Sampling speeds up to 40 revolutions per second are available. Two-pole switching can be supplied to any phase angle by adding a second row of contacts and incorporating two synchronized air jets in the shell. Since the contacts do not wipe against each other, signals of 1, 2, and 3 millivolts can be transmitted completely free of noise without amplification or filtering of any kind.

Circle 664 on Page 19

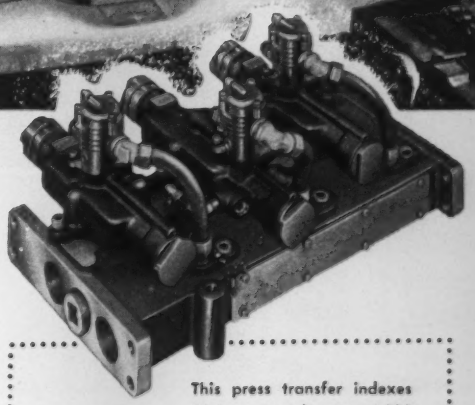
Valvair® deceleration manifolds provide safe, velvet-smooth control of high-speed press transfer shuttles



Performance of Valvair deceleration manifolds on press transfers maintains a steady high rate of production through a major automotive manufacturer's fully-automated 5-press stamping line. Valvair design assures necessary rapid movement of the transfer mechanism, with precisely controlled deceleration of the 200 lb. shuttle at each end of the cycle. And, positive cushioning of shuttle travel prevents damage to the transfer mechanism . . . protects valuable dies.

Valvair's deceleration manifold assembly uses only three SPEED KING valves; two to control cylinder movement, and one as a directional valve to select free or restricted exhaust for cushioning. Just two limit switches are needed to control cushioning action — a quick adjustment of exhaust restriction precisely regulates cushioning rate. Simplicity of design, plus SPEED KING multi-million cycle dependability, assures peak production rates, with minimum in-service downtime.

If control of fast-moving reciprocating mechanisms is a problem in your plant, ask your nearby Valvair representative for his recommendations. He's only a telephone call away.



This press transfer indexes 26 in. per cycle, at a 1,000 cycle/hr. rate. Valvair's compact, 3-valve deceleration manifold controls its horizontal movement . . . requires minimum mounting space . . . simplifies piping and wiring.

For more information, write for Bulletin G-3A. Address Dept. AU859, Valvair Corporation, Akron 11, Ohio.

Representatives in principal cities

Valvair AKRON 11, OHIO

DIVISION OF INTERNATIONAL RATIO ECONOMY CORPORATION (IREC)

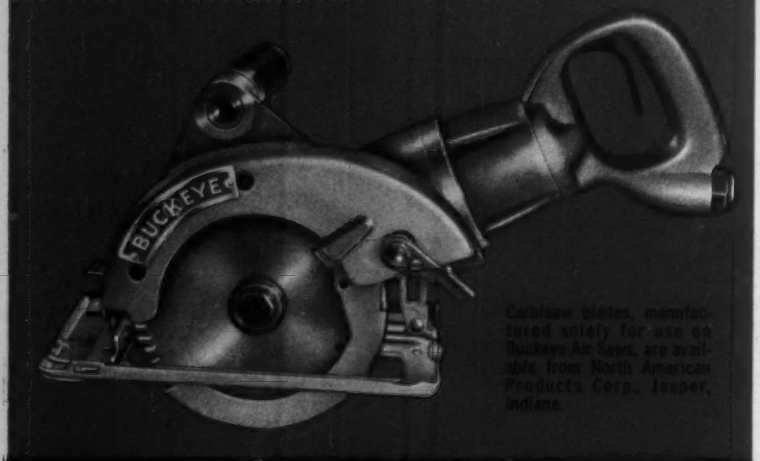
Other INDUSTRIAL DIVISIONS of IREC The Sinclair-Collins Valve Co. The Bellows Co., Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio.

8018

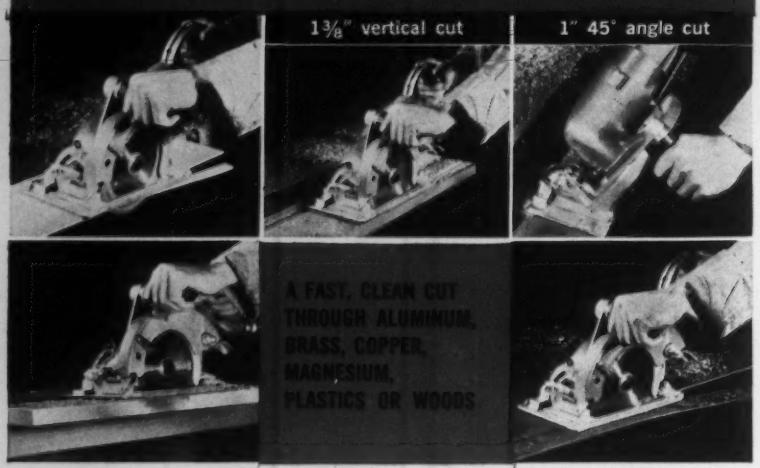
Circle 665 on Page 19

the most useful SAW you'll ever see!

BUCKEYE



Carbisaw blades, manufactured solely for use on Buckeye Air Saws, are available from North American Products Corp., Jasper, Indiana.



Just squeeze the safety throttle and this portable saw starts cutting—right now! Powerful, governed Buckeye air motor is geared to produce the torque needed for a fast, sharp cut, even on non-ferrous materials. No backups to allow saw to regain speed, and no burnouts from overloads. Lightweight—16½ pounds—perfectly balanced for ease of handling. ⅝" arbor accommodates blades for fine, medium and heavy duty work.

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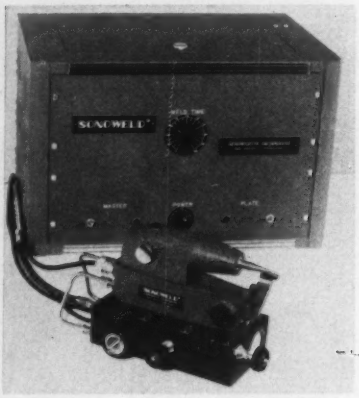
Write, on your company letterhead please, for your free copy of Catalog G-10, listing all Buckeye air tools—drilling, fastening, abrasive and specials.

INDUSTRIAL AIR TOOLS SINCE 1920

Buckeye Tools CORPORATION

3009 SPRINGBORO PIKE, DAYTON, OHIO

coiled steel stock at a plant of the Air Preheater Corp. In addition to permitting a step up in press speed from 80 to 180 strokes per minute, the carbide dies increased the time between regrinds from 52 to 431 hours of press operation. Translated into hits, the new dies allowed 18.3 times as many hits on the coil stock as did the steel dies. The carbide die inserts and punches were provided by Kennametal Inc.



INSTRUMENT-TYPE ultrasonic welder designed to make welds in small parts and delicate assemblies has been developed by Aeroprojects Inc. Operating with a power capacity of 100 watts, the welder will handle many difficult-to-join metal combinations such as silicon or germanium joined to aluminum or gold wire. The unit is also capable of joining high resistance wires with thicknesses of 0.003 to less than 0.001 inch. Since ultrasonic welding is accomplished without melting or fusion and no electrical current passes through the parts being joined, contamination of surrounding areas by sputter, arcing, or spatter is eliminated.

Mechanized Shiploader Handles Record Tonnage in Loading Coal

RECORDS are made to be broken and that is exactly what has occurred at Chesapeake and Ohio Railway's new coal loading dock at Toledo, Ohio. In operation since August, 1958, the $7 million mechanical shiploader has a rated capacity of 6000 tons of coal an hour when loading ships from railroad cars.

This past June the *L. C. Hanna*, a Bethlehem Steel Co. vessel, docked at the installation, was loaded with 6653 tons of coal, and was under way again in a total elapsed time of one hour and 30 minutes. This set a record for fast coal handling

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If your problem is in the field of speed control, tension control, power transmission, or testing, Dynamatic Eddy-Current Equipment is the ideal solution. Dynamatic Ajusto-Spede Drives, Couplings, Brakes, and Dynamometers are solving these problems in virtually every industry—in both plant machinery and end product applications. Dynamatic equipment can do the same for you.

Ajusto-Spede Drives and other Dynamatic units offer the important advantages of rapid response, wide speed range, quiet operation, low power loss, low maintenance costs, and stepless adjustable speeds from an AC power source.

For complete information about Dynamatic problem-solving equipment, check with your local Eaton-Dynamatic representative or distributor.

The New Quill-Type Ajusto-Spede Drive provides controlled adjustable speeds for applications from ½ HP through 7½ HP. Together with the new K-2 Electronic Control and push-button station, this new Ajusto-Spede Drive comprises a compact, low-cost, 3-unit drive package.

Send for Illustrated Descriptive Literature Covering New Models ACM-903 and 904 Ajusto-Spede Drives

Red tint indicates adjustable speed member.

EATON®

***When You See the Name Ajusto-Spede You Know it's an Eaton Product**

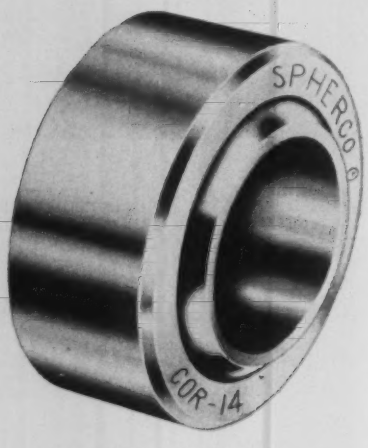
EATON DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

PIONEER IN EDDY-CURRENT EQUIPMENT

Circle 667 on Page 19

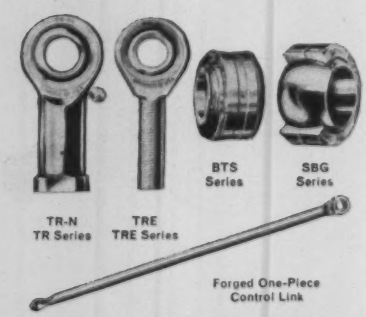
SPHERCO® BEARINGS

AVAILABLE IN A COMPLETE RANGE OF SIZES



FEATURING...

- Quality engineered and produced
- Solid inserts
- Swage staking of 3-piece rod end
- Wide range of metals for races



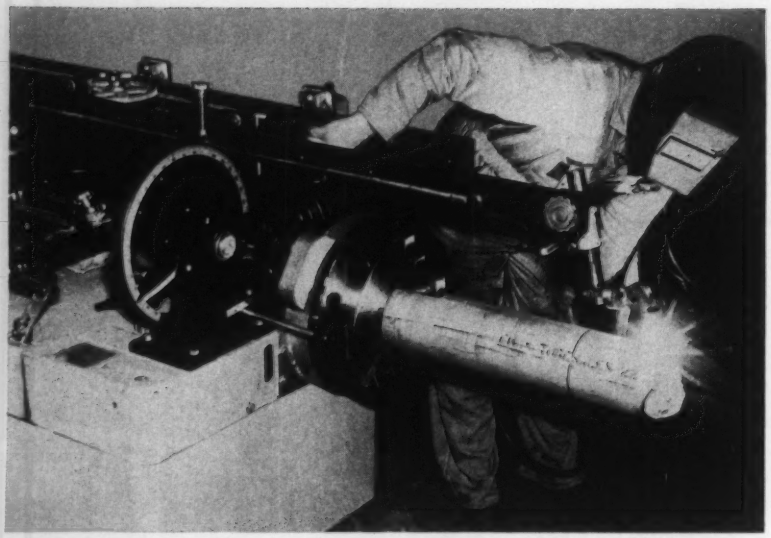
WRITE FOR BULLETIN 257

SPHERCO

A PRODUCT OF
SEALMASTER BEARING DIVISION
STEPHENS-ADAMSON MFG. CO.

22 RIDGEWAY AVE. • AURORA, ILL.

Circle 668 on Page 19



MATCHING contours for a welded T-joint in stainless steel pipe can be a time-consuming job when done manually. General Electric Co. personnel at the Hanford atomic plant used a 6-step process that entailed making a layout, marking the pipe, sawing, burning, and finally hand-grinding and bevelling to a proper fit. Contour cutting is now done in a single operation by an automatic pipe cutter which combines a Mechanical Draftsman manufactured by Steffan Mfg. Corp. with a Heliarc torch made by Linde Air Products Co. Four dials control the automatic operation of the machine. One dial is set to the OD of the pipe being cut; a second dial is set to the OD of the mating pipe; a third dial controls the angle of intersection of the two pipes; and a fourth dial controls the distance of offset when one pipe is off-center of the other pipe, requiring a deeper cut on one side. Pipes up to 10 inches in diameter can be cut by the machine, and there is no limit to the number of configurations possible.

on the Great Lakes. During the short span of time, 112 hopper cars of coal were dumped and loaded into the holds of the vessel. Of this total, 92 cars were handled during the first hour of operation. Although the fast time set a record of 4435 tons an hour, it is still below the rated capacity of the equipment and will probably be broken in the near future.

SPOTLIGHTING PEOPLE

Jacob J. Jaeger elected president of Pratt & Whitney Co. Inc. . . . **Walter E. Sargent** appointed supervisor of production engineering at Stromberg-Carlson—San Diego. . . . **R. J. McIntosh** named plant manager of the structural steel manufacturing division at R. C. Mahon Co. . . . **Edward L. Holbrook** named head of the Eastern Div., Modernair Corp. . . . **James A. Neff** appointed vice president and general manager of Mechanical Air Controls Inc. . . . **E. B. Fitzgerald** named vice president in charge of engineering at Cutler-Hammer Inc. . . . **Robert B. Shulters** appointed director of engineering at the Aurora, Ill., works of Thor Power Tool Co. . . . **Charles J. Lawson Jr.** named director of manufacturing services for International Business Machines Corp. . . . **John D. Weber** elected vice president of Swartwout Co. and manager of the Autronic Control Div. . . . **Adolph Vlcek Jr.** appointed director of manufacturing for the Baltimore Div., Martin Co. . . . **Joseph J. Roman** appointed general quality control manager for all products and processes of Allen B. Du Mont Laboratories Inc. . . . **Matthew Cordova** named works manager for Tempo Instrument Inc. . . . **H. E. Temple** appointed director of engineering for the Food Machinery Div., Baker Perkins Inc. . . . **Robert R. Allen** named director of engineering, research, and development of Hewitt-Robins Inc. . . . **Harold C. Hanson** appointed assistant chief engineer of Magnetic Controls Co. . . . **John S. Hall** named manager of manufacturing for the Gabriel Electronics Div., Gabriel Co. . . . **Howard Mann** appointed production manager, and **Irwin Rubin** named chief manufacturing engineer for a new semiconductor

MICRO-PATH's

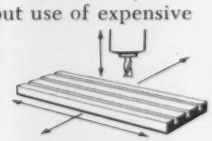
dual track RECORDING...

1 billion to 1 reliability in performance!

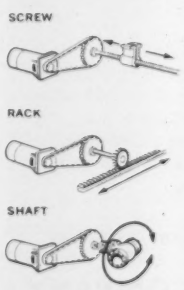
11 CHANNELS

Micro-Path's magnetic tape accommodates 11 individual tracks, allowing for many prime and auxiliary functions.

MICRO-PATH is the first low-cost automation system, recording programs directly without use of expensive computers or highly trained technicians. It utilizes magnetic tape and is capable of producing motion in any of 3 axes, *individually* or *simultaneously*.



To convert magnetic tape recordings to motion Micro-Path utilizes a special motor known as a PULSERVO. Unique in design, the PULSERVO responds to individual electrical pulses, the armature rotating 5° for each pulse command. A continual series of pulses thus creates continuous rotation, the PULSERVO keeping in step exactly and reversing according to the signal received. The PULSERVO can be attached as a packaged unit to a screw, rack or shaft to automate various types of equipment, from machine tools to industrial controls. This flexibility accommodates installation on existing equipment as well as easy incorporation in new designs.



With millions of pulses magnetically stored on each tape the question arises, how dependable is the MICRO-PATH system? During recording, motion commands for each axis are duplicated *in two separate channels*. Playback generates two identical electrical programs in exact unison. These are fed simultaneously to the PULSERVO. Loss even of a single pulse in one channel is remote, but should it occur, an identical pulse is supplied by the opposite track. Dual track recording in MICRO-PATH thus insures an electrical reliability of 1 billion to 1 at the recording head... *equivalent in machine tool operation to .001" in 15 miles of table travel!* Loss of program from external causes such as dust, scratches, wear or other similar defects is thus virtually nil! A closed loop Pulservo system thereafter faithfully follows commands and stays on program.

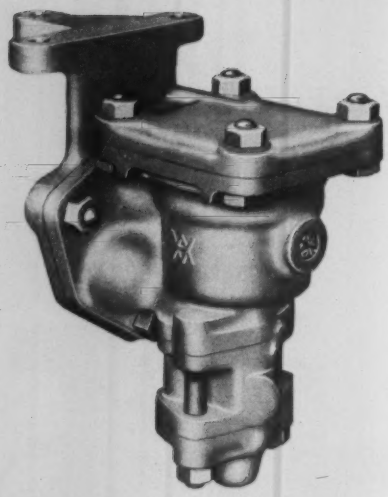
Our engineers will be glad to tell you how MICRO-PATH can automate your machines or equipment.
For the complete MICRO-PATH STORY ask for brochure on your company letterhead!

MICRO-PATH INC.

A Subsidiary of Topp Industries Inc.
4949 West 104th Street • Inglewood 2, California
Phone: SPring 6-0450

Circle 669 on Page 19

Typical Control Functions solved by AIR CIRCUITRY



● The H-5 RELAYAIR Valve, one of many Westinghouse Air Circuitry Components, is a pilot operated, directional control valve. It may be normally open or normally closed, depending upon port connections.

Various spring settings provide operating pressures from 3 to 150 psi. An easily removable pipe bracket permits removal of valve without disturbing pipe connections.

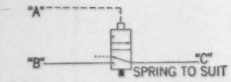
Envelope size: 7¼" x 7⅜" x 4⅜"
Maximum supply pressure 200 psi.

Typical Applications—In addition to the illustrated functions, this highly versatile valve has been and can be used in all conceivable types of air circuits. Some of these are as follows: cycling operations, safety interlocks, low pressure alarm signals, emergency cut-off of power, emergency brake applications, remote control station relays, sequence control timing, and many many others.

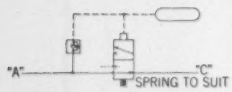
If you have a control problem, let us know about it. It can probably be solved with Air Circuitry. For more information, ask for Catalog A5-81.01.

What is air circuitry?

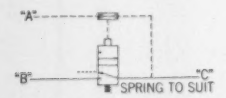
This is the Westinghouse term for application of pneumatic control systems to industrial production operations. Safe, economical, precise Air Circuitry is now being used to solve the most rigorous and complex control problems in industry. Westinghouse Air Brake has pioneered the application and development of air control for more than 80 years. Today our engineers can design an air circuit which will help you boost production and cut costs in your plant or shop.



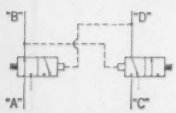
1. RELAY—To increase flow or pressure in an air circuit. An air signal directed to line "A" overcomes a spring opposed diaphragm to connect line "B" to line "C." Various spring values determine operating pressure.



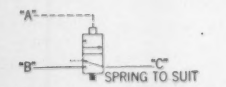
2. TIME DELAY—To provide automatic power unloading. Air signal pressure in line "A" flows through the device to line "C" to perform specified operation. A check valve with choke and a volume provides a time delay by requiring a predetermined pressure be built up before line "C" is vented to atmosphere.



3. LOCK-UP—To provide a hold-in feature. Air signal in line "A" connects line "B" to line "C." Air from line "C," through a shuttle valve, holds this connection when signal air is vented.



4. CRISSCROSS INTERLOCK — To prevent energizing one line before another is vented. With lines "A" and "B" energized with air pressure, line "D" is vented to atmosphere. Line "D" cannot be energized until line "B" is vented. The converse is true when lines "C" and "D" are energized.

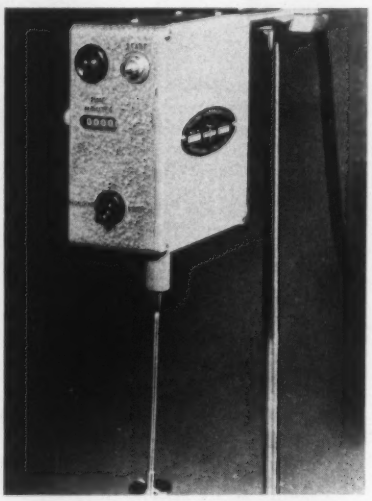


5. SEQUENCE INTERLOCK—To insure one function is performed before another is initiated. Line "A" must be energized to a predetermined pressure before line "B" can pass air to the next function.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor

WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING 6, PENNSYLVANIA

plant now under construction in El Monte, Calif., for Hoffman Electronics Corp. . . . **Walter Hasenzahl** appointed director of manufacturing engineering of the Crosley Div., Avco Corp. . . . **Robert S. Handley** named manufacturing manager of three plants of Continental-Diamond Fibre Corp., subsidiary of the Budd Co. . . . **Samuel B. Sherwin** appointed manager, and **Wladimir Reichel** named engineering manager of Ketay Dept., Norden Div., United Aircraft Corp. . . . **Frank Curthbertson** appointed director of production engineering, **Howard Fish** named manufacturing manager, **Charles Rose** appointed manager of production control, and **Lawrence Bossman** named works engineer at the AC Spark Plug Div., General Motors Corp. . . . **Irwin W. Killian** elected president and chief executive officer of Pines Engineering Co. Inc. . . . **James R. Lawler Jr.** of Lawler Automatic Controls Inc. elected president of the Fluid Controls Institute Inc. . . . **James E. Kennedy** named production manager at Rubbermaid Inc. . . . George

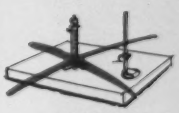


GELATION timer available from Arthur S. LaPine and Co. is used for determining the gelation or pot-life time of synthetic adhesives, silica sols, drying oils, plastics, and other liquids that gelinate. A weighted disc immersed in the liquid is subjected to a simple harmonic vertical motion, with a periodic time of one minute, by an electric motor. A link connecting the disc shaft and the motor is under tension during both up and down strokes of the disc until the liquid gelinates sufficiently to support the disc. Link is then subjected to compression which causes a contact in the link to close, actuating a relay, causing the motor to stop and a neon light to illuminate.

SHORT-CUT TO PRODUCTION!

ONE STEP INTO THE FUTURE ELIMINATES THESE COSTLY STEPS OF THE PAST

CAM ENGINEER


LAYOUT

INSPECTION

MODEL SHOP

Numeri-Trol slashes lead time from months to days, cuts changeover time from weeks to hours; here's how:

Typical fuel control cam production process is simplified to (1) preparation of machine control tape *directly from engine designer's performance curve*, and (2) inserting the tape into Numeri-Trol's control cabinet for *fully automatic production!*

NUMERI-TROL

59-29

Tape-Controlled Cam Milling Machines by Ex-Cell-O

Designed to Save Time!

- Drastically cut lead time, eliminate tooling costs, reduce machining time of cams for aircraft or missile fuel systems, small turbine blades and other complex prototypes and production parts.
- Precision-built especially for use with high performance pulse data inputs.
- Rugged construction with anti-friction table and cross-slide bearings, and servo-actuated hydraulic drive motors.
- Lateral movement of work head, transverse cross-slide and 360° work indexing are fully tape-controlled.
- Simple control and automatic functions eliminate human error.
- No need for blueprints or models. Numeri-Trol permits maximum security for advanced projects.

Have a tough part that's costly to produce? Write direct or ask your Ex-Cell-O Representative how Numeri-Trol Cam Milling Machines and Precision Profiling Machines can save you time and money.

EX-CELL-O FOR PRECISION XLO

EX-CELL-O CORPORATION *Machinery Division*
DETROIT 32, MICHIGAN

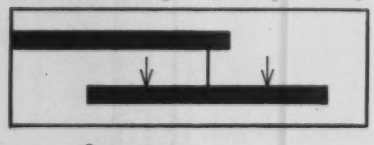
EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • THREAD AND GROOVE GAGES • GRANITE SURFACE PLATES • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

Circle 671 on Page 19

How did this team solve an age-old weighing problem?

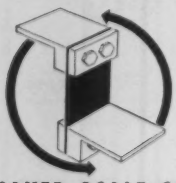
Since 5,000 B.C. men have been trying to devise a pivot balance that would be highly sensistive yet remain accurate. The breakthrough came in 1956 when the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen, aware of industrys great cumulative loss of materials in weighing operations, had invented a revolutionary new scale.

Knife-edged pivots that progressively wear and change were replaced by Thayer Flexure Plates that move only .001", yet accurately reflect the minutest changes in weight. This *firmly joined* lever withstands shocks and vibrations indefinitely. Dirt and dust are no longer a problem. Thayer guarantees this leverage system accurate for the life of the scale.



How Can It Save You Money Year After Year?

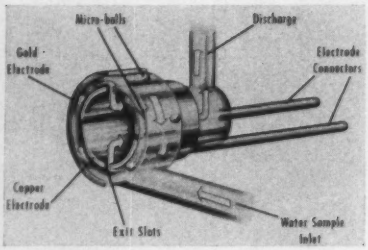
Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling *by weight*. Literature on its application to filling, batching and checkweighing operations is available on request.



THAYER SCALE

AUTOWEIGHTION SYSTEMS FOR FILLING, BATCHING AND CHECKWEIGHING

THAYER SCALE CORP. 5 THAYER PARK, PEMBROKE, MASS.

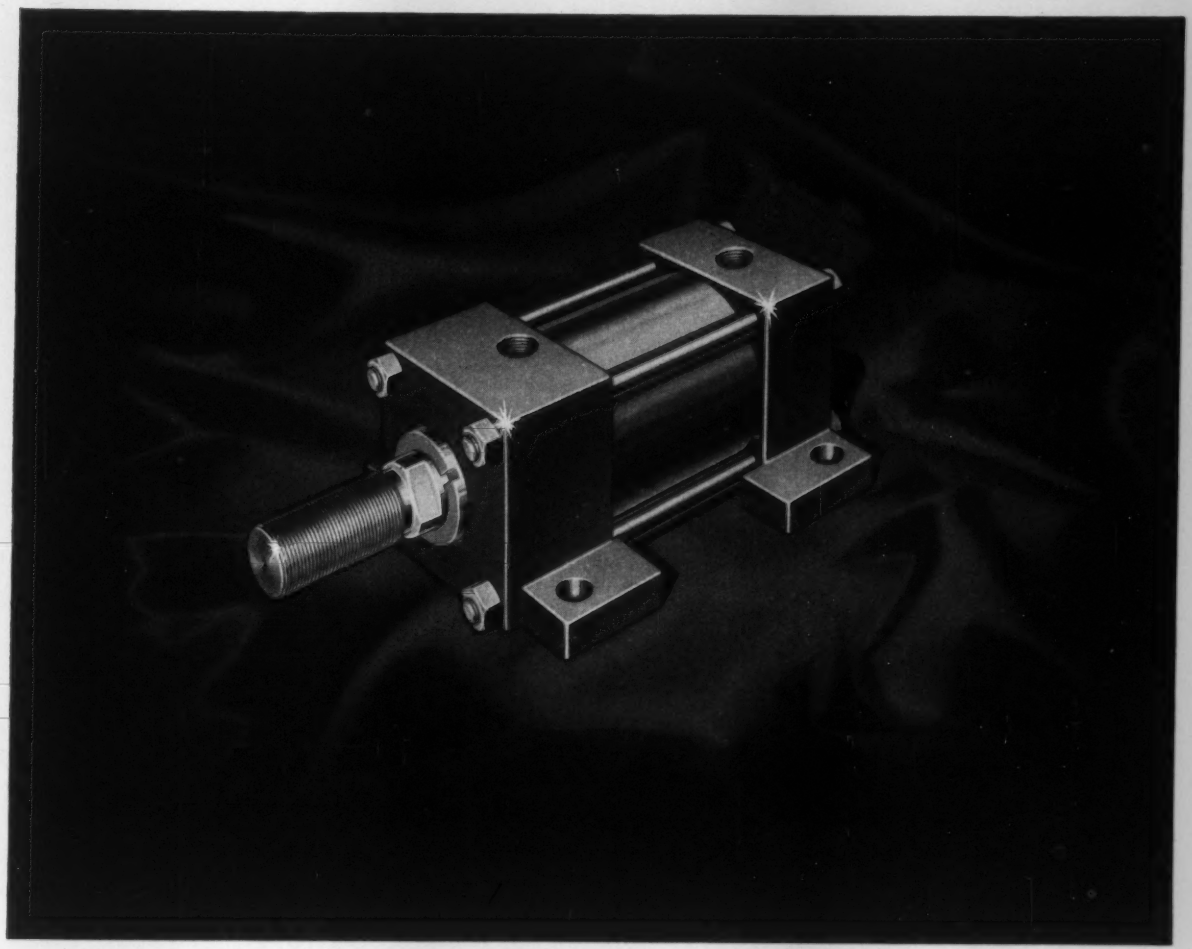


RESIDUAL chlorine analyzer featuring a unique self-cleaning electrode assembly is being manufactured and marketed by Fischer & Porter Co. under exclusive license agreement with Chlorator, G.m.b.H., a German firm. As shown in the diagram, the unit uses electrodes of dissimilar metals to generate a current in proportion to the amount of free or total residual chloride in the solution. Retained in the electrode chamber permanently are a number of small glass balls which circulate across the surfaces of the electrodes, keeping them clean. Thus, clean electrodes are maintained at all times, assuring accurate chlorine content readings.

Russell appointed chief engineer of Amchem Products Inc. . . . **Walter E. Carpenter** named chief engineer of the Hudson Lamp Co.

SPOTLIGHTING PLANTS

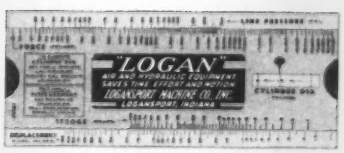
National Semiconductor Corp. is the name of a new company which will develop and manufacture semiconductor devices. Products of the new company will include silicon transistors, silicon diodes, and silicon rectifiers. . . . **Norton Co.** has purchased the inventories, machinery and equipment, drawings, designs, and certain other assets of Gould & Eberhardt Inc., manufacturer of shapers and gear hobbing machines. . . . **International Business Machines Corp.** has opened a new 72,000 sq ft manufacturing plant at Essex Junction, Vt., for the manufacture of relays for data processing equipment. . . . **Monitor Systems Inc.** is the name of a new subsidiary of Epsco Inc., manufacturer of electronic data processing and telemetry equipment. The new company will be located in Philadelphia and will engineer and produce high speed monitor and automatic checkout systems. . . . **Singer Mfg. Co.** has created a Special Products Div. which will include the Diehl Mfg. Co.; Haller, Raymond and Brown Inc., and Singer's Military Products Div. . . . **American Machine & Foundry Co.** has made



Illustrated—Logan Super-Matic Cylinder Meets J.I.C. Standards

Look to Logan

the ultimate in hydraulic cylinder design



FREE SEND FOR THE "LOGAN CALCULATOR"

MEMBER: Natl. Mach. Tool Builders' Assn.; Natl. Fluid Power Assn.

LOGANSPORT MACHINE CO., INC.
848 CENTER AVENUE, LOGANSPORT, INDIANA

PLEASE SEND COPY OF CATALOG:

- ☐ 100-1 AIR CYLINDERS
- ☐ 100-2 MILL-TYPE AIR CYLS.
- ☐ 100-3 AIR-DRAULIC CYLS.
- ☐ 100-4 AIR VALVES
- ☐ 100-5 LOGANSQUARE CYLINDERS
- ☐ 100-5-1 ULTRAMATION CYLINDERS
- ☐ 300-2 PRESSES
- ☐ FACTS OF LIFE
- ☐ 200-1 HYD. POWER UNITS
- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 and 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
- ☐ 300-1 CHUCKS
- ☐ ABC BOOKLET
- ☐ CIRCUIT RIDER

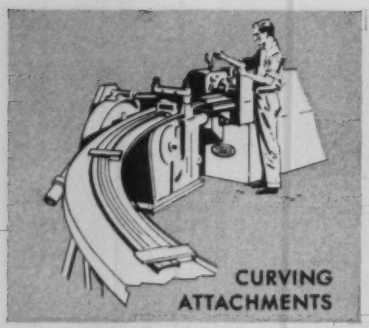
TO:

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

Circle 673 on Page 19



YODER COLD ROLL-FORMING EQUIPMENT

for profitable mass production

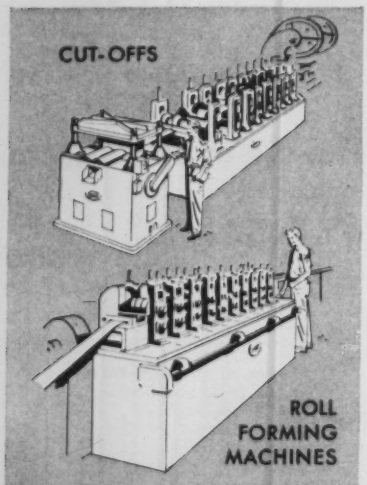
High speed, YODER Cold Roll-Forming machines are the most economical method for mass producing structural or ornamental shapes. One machine with one operator can form up to 40,000 feet of shapes per day. Even on a part-time basis, a YODER Cold Roll-Forming machine can prove to be a profitable investment.

YODER flexibility works for you too, curving, coiling, ring forming, multiple roll-forming and embossing—on a wide variety of metals—can be incorporated into your production line. Practical, YODER-engineered design minimizes maintenance and downtime . . . assures uniformity, accuracy and reliability of your end product.

In addition to Roll-Forming machinery, YODER also makes a full line of Rotary Slitting equipment, Pipe and Tube mills. Send for the fully descriptive Cold Roll-Forming Book.

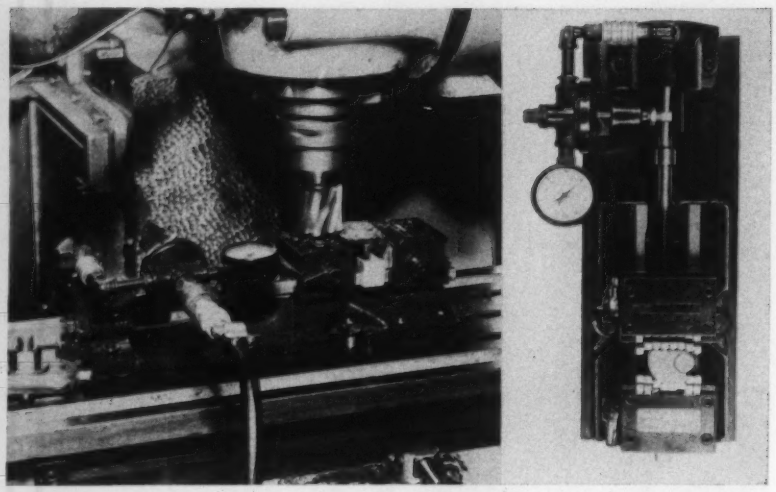
THE YODER COMPANY

5526 Walworth Ave. • Cleveland 2, Ohio



ENGINEERING YODER MANUFACTURING COLD ROLL FORMING MACHINES

Circle 674 on Page 19



CONTOUR GRIP holding fixture developed by the Die Supply Div., E. W. Bliss Co., uses a set of movable fingers which mold around the part being held, no matter what its shape. When the jaws release the workpiece, the fingers remain in the same relative position as they were when gripping the part, making it quick and easy to drop the next part into position and tighten up. If a part of different shape is to be processed, the operator presses levers on each side of the jaws which move the fingers back to a parallel position. When the jaws are closed, the fingers will form a matrix around the new piece. The gripping fixture can be actuated hydraulically, pneumatically, or through solenoid valves, and can be synchronized with the operation of the machine tool.

its subsidiary, Potter & Brumfield Inc., a division and has changed its name to Potter & Brumfield Div. . . . **Moog Servocontrols Inc.** has created a new Industrial Div. which will handle all non-military product lines. The new division will market electrohydraulic systems, servovalves, and will offer controls and systems engineering service. . . . **Warner & Swasey Co.** has announced plans for the construction of a new Research Center in Solon, Ohio. The 40,000 sq ft building is expected to be completed by the end of this year. . . . **Computer Sciences Corp.** is the name of a new company which will serve both computer users and manufacturers in the specialized field of automatic programming of electronic data processing systems. A principal specialty of the new company will be the development of compiler systems which are used in preparing instructions for computers.

MEETINGS AND EVENTS

Aug. 10-13—

Society of Automotive Engineers. National west coast meeting to be held at Hotel Georgia, Vancouver, B. C. Additional information is available from John A. C. Warner, SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Aug. 19-22—

American Institute of Electrical Engineers. Summer general meeting to be held in Sacramento, Calif. For further information, contact N. S. Hibshman, AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Sept. 1-3—

Association for Computing Machinery. Fourteenth national conference to be held at Massachusetts Institute of Technology, Cambridge, Mass. Additional information is available from Dr. Frank M. Verzuh, Computation Center, MIT, Cambridge, Mass.

Sept. 13-17—

Pressed Metal Institute. Annual meeting to be held at the Stanley Hotel, Estes Park, Colo. Additional information is available from Harold A. Daschner, PMI headquarters, 3673 Lee Rd., Cleveland 20, Ohio.

Sept. 15-17—

Ohio State University. Short course on Advanced Principles of Flow Measurement sponsored by the Flow Measurement Research Group, Mechanical Engineering Dept. Meet-

MAGNETS
PLUS
AUTOMATION
EQUALS
MAGNAmation®

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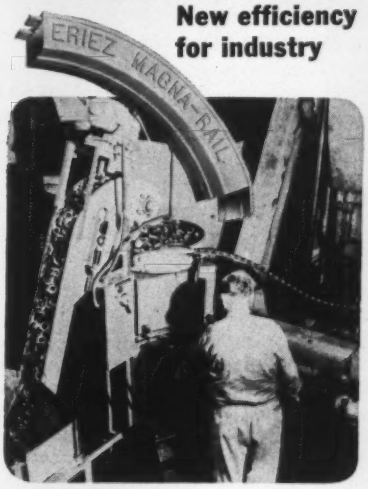
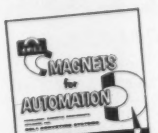
ERIEZ

New efficiency
for industry



MAGNA RAILS. Lifetime powered, non electric magnetic elements that convert ordinary belt conveyors to *magnetic* conveyor elevators. Will convey ferrous items up inclines as steep as 90° — quickly, safely, with positive hold. Easily installed under existing lines, or incorporated into new equipment. Increases production. Reduces manpower needs. Saves valuable factory floor space.

VERSATILE MAGNA RAILS ARE AVAILABLE IN MANY MAGNETIC STRENGTHS IN VARIOUS BOLT-TOGETHER LENGTHS AND IN STRAIGHT AND CURVED SECTIONS, ASSURING YOU PROPER UNITS FOR SOLVING YOUR HANDLING PROBLEMS REGARDLESS OF SIZE OF PARTS.



We work closely with design engineers, OEMs, etc. Contact us any time.

FREE! Comprehensive "Belt Conveyor" portfolio. Complete info on magnetic components, applications, test data, installation photos, etc. Write today to Eriez Manufacturing Co., 119VA, Magnet Dr., Erie, Pa.

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ing will be held at Ohio State University, Columbus, Ohio. Additional information is available from Charles F. Sepsy, Mechanical Engineering Dept., Ohio State University, 206 W. 18th Ave., Columbus 10, Ohio.

Sept. 17-18—

American Society of Mechanical Engineers. Engineering management conference to be held at the Statler-Hilton Hotel, Los Angeles, Calif. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 21-22—

Standards Engineering Society. Eighth annual meeting to be held at the Somerset Hotel, Boston, Mass. For further information, contact Charles T. Ajamian, P. O. Box 538, Wayland, Mass.

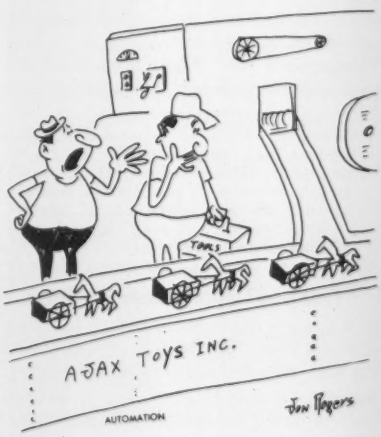
Sept. 21-23—

Business Forms Institute. Fall Outing Meeting to be held at Skytop Lodge, Skytop, Pa. Additional information is available from BFI headquarters, 20 Church St., Greenwich, Conn.

Note: In the July 1959 issue, this meeting was erroneously listed as being held on Sept. 16-17 at the Greenbrier Hotel, White Sulphur Springs, W. Va.

Sept. 21-25—

Instrument Society of America. 14th annual Instrument-Automation Conference to be held at the International Amphitheatre, Chicago. Additional information is available from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.



"Keeps putting the cart before the horse!"

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MAGNA ROLLS. Permanently powered, non electric automation units for use in magnetic conveying systems. Hold, control, elevate, change direction flow of ferrous materials – from small parts to large sheets. Can be used as head pulleys or in systems not utilizing belts. For *faster, shorter, safer* conveyor lines that move at peak speeds for peak production!

MAGNETIC STRENGTH IS GUARANTEED INDEFINITELY • NON ELECTRIC; NO WIRES, ATTACHMENTS, FUSES • NO MAINTENANCE • EASILY INSTALLED ON NEW OR EXISTING EQUIPMENT • LOW INITIAL COST; NO OPERATING COSTS • VARIOUS DIAMETER WIDTHS, STRENGTHS, CONTOURS, ETC., TO MEET SPECIFIC NEEDS.

Need assistance? Contact us; we work closely with design engineers, OEMS, etc., on models and pilot set ups.

FREE! Send for big 56-page "Magnetic Ideas for Automation" booklet. Packed with idea-sparking sketches for proved-in-use installations, etc.

Eriez Mfg. Co., 119VB Magnet Dr., Erie, Pa.

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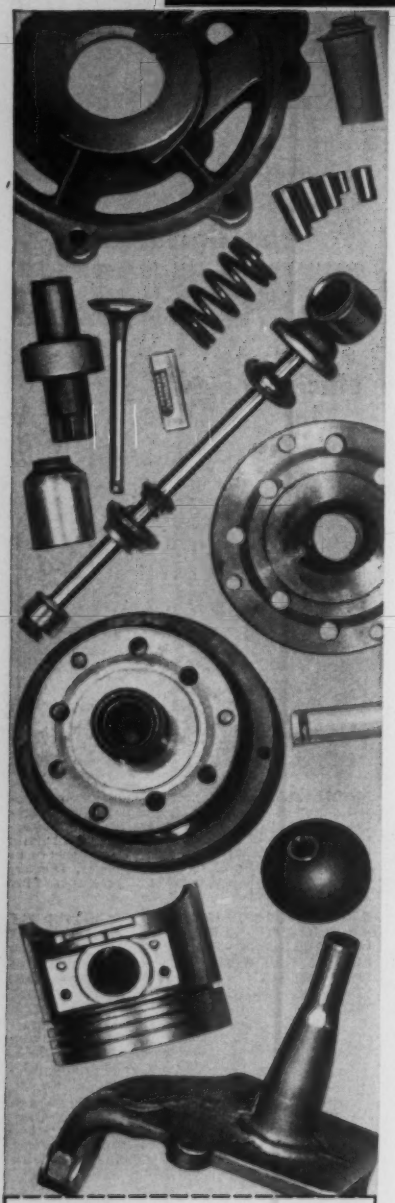
practical automation ideas ....#2



GEAR-O-MATION
Division of Michigan Tool Company
7171 E. McNichols Rd., Detroit 12, Mich.

Yes! I want to see the time- and money-saving ideas in your new "Idea File." Have your field engineer show it to me soon!

Name_____

Company_____

Street_____

City_____

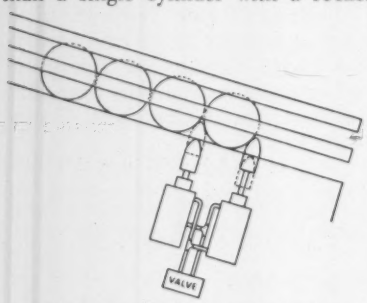
Why Waste Floor Space?

Often a Gear-O-Mation 'overhead' demand storage unit can provide all the in-process storage and demand feeding you need. Can be used between widely separated operations. Tracks of unit are self-cleaning to avoid maintenance up under the ceiling.

Want to see Gear-O-Mation's "Idea File"? Every Gear-O-Mation field engineer has one. Drop us a line and we'll tell the one handiest to your company.

Two Cost Less Than One

Simple twin air cylinders, working alternately can release parts for demand feed at a lower cost, frequently, than a single cylinder with a rocker



arm. The arrangement is also more positive and can give faster 'in' and slower 'out' movement to prevent parts jamming or accidental escape.

The Old Town Pump

Many practical automation ideas come from old principles. Example: Use of the old town water pump to elevate parts on demand. Instead of bringing up water, a cage instead of a plunger brings up a part. The cage opens the gates. Elevation is by a simple piston rod.

When it comes to actuating devices —electrical, mechanical, hydraulic or pneumatic—it is Gear-O-Mation's policy to use only proven equipment, thus lessening chances of service interruptions and making sure reliability is not sacrificed.

"Freeway" Interchange for Parts

If you have the need to switch parts on demand from, say, either of TWO 'inbound' to either of two 'outbound' tracks, Gear-O-Mation has a simple way of doing it with air operated gate. Particularly useful where you are feeding two machines from two others.

Flip-Flop Press Feeder

An oscillating arm with built-in hydraulic clamp can pick up a part from the loading chute, load it into a press, reverse it, remove it and place it on the unloading chute or conveyor.

A basic principle at Gear-O-Mation is to look always for the simplest answer to any problem of handling of parts in process. Usually they find it, too. Nine times out of ten, the simplest way is usually the most practical.

2-Strand Chain Does Whole Job

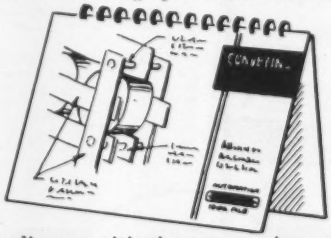
Rotating continuously in a vertical plane, a 2-strand chain with A, B and C pockets receives parts, feeds them into machine 'A' for operation 'A', takes them back, feeds them into machine 'B', gets them back again, feeds them into machine 'C'. Exit chutes into machines serve as loading magazines.

Automating for Worker Safety

Positioning of small parts in relation to large ones in welding or riveting machines sometimes presents a safety hazard to hands. A simple solution is a positioning arm with a formed end which swings into place by simple cam action after the large part is inserted. The small piece is then pushed into position by the machine and the positioning arm retracts, leaving the part in place.

SEE THIS "IDEA FILE"

Every Gear-O-Mation field engineer now carries with him an "Automation Idea File." It contains sketches and details of practical answers to many parts handling problems—orienting,



feeding, positioning, conveying, distributing, etc. These ideas will suggest variations to suit your exact needs. Have a Gear-O-Mation field engineer go through the "Idea File" with you soon! Use the handy coupon at left.

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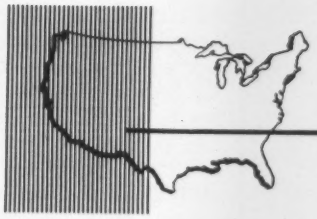
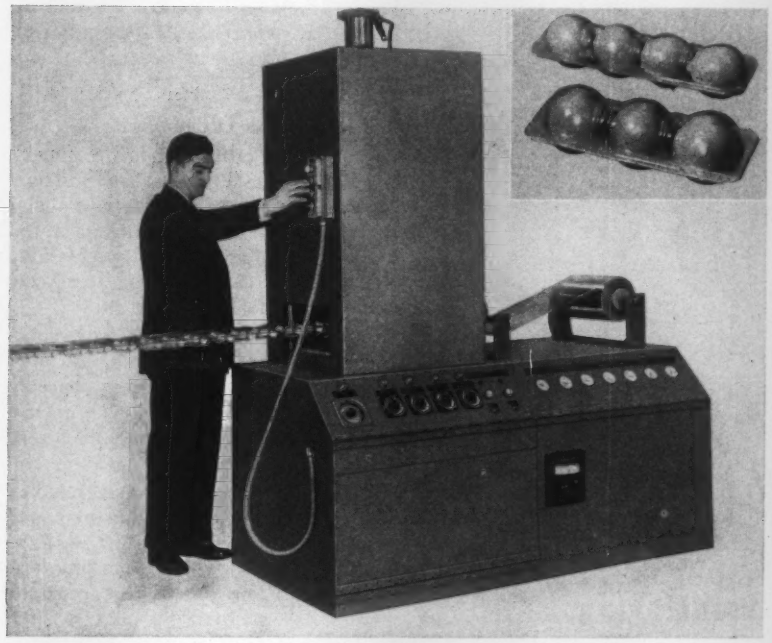


western trends

BY PATT PATTERSON
Los Angeles, Calif.



VISUAL food packaging by automatic machines is an example of improvements being made in food processing industry. Illustrated equipment developed by Auto-Vac Co., Div. of National Tool Co., pressure forms biaxially oriented sheet styrene into containers. Accessory indexing equipment automatically transfers items to and from a mold; the forming cycle—including heating, heater dwell, forming, cooling, and air blow-off operations—can be controlled through five automatic timers. The nontoxic packages protect products from moisture absorption under refrigeration and extend shelf life tremendously (shelf life of tomatoes is 3 to 4 times longer than when packaged in cardboard or papier-mache).

Packaging Highlights

IN the food processing industry automation is continuing to gain ground, especially on the Pacific Coast. As labor costs rise, and the demand for prepared foods grows, more plants are turning to automatic equipment to process and pack the food products. The requirements for sanitation and consistent quality have dictated the large scale use of automatic equipment. A leading food packer has recently stated that his plant "could go completely automatic." A major problem still existing in such a changeover, however, is the consideration that must be given to decision making in the processing cycle. It is still necessary for human operators to make the vital decisions in food processing and packing.

Liquid Filling

Beverage bottling plants have long been automated to some extent. It seems long ago that a major cola producer garnered public attention with an antiseptic white plant featuring an automatic bottling machine in operation before a large window. The machine in the window concept is gone, but behind the scenes, beverage bottlers are still automating.

A number of bottlers in the West are turning to cans for their soft drinks. The latest is club soda packaged in cans. A large soft drink bottler who has recently innovated this method on the Pacific Coast uses an automatic line to package the popular drink mix. As customers accept the new package, other drink mixes may be marketed in cans rather than bottles.

In a typical filling line, a 50-spout rotary filler injects the soft drink into a sterile can. It then travels by conveyor, held firmly enough that not a drop sloshes over, to an 8-spindle can sealer.

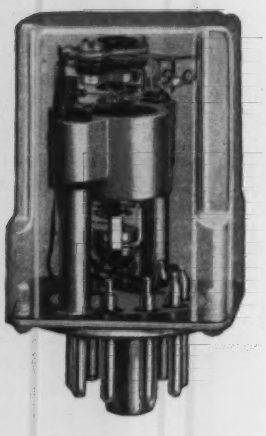
Another conveyor splits the run, sending half of the sealed cans to a 6-pack packing machine, and the other half to a carton packer, both as completely automatic as the filler and sealer. Only one or two operators are required for an entire line which can turn out up to 1200 cans of soft drink per minute.

In the bottling of wines, automatic processes are also gaining favor. At the Charles Krug winery in St. Helena, Calif., bottles of select wines are filled, conveyed to a second filler which automatically tops off each bottle with the proper amount of wine, and then processed through a labeler and capper. After capping, the bottles go to an automatic case loader and sealer. On a line where half gallon jugs are filled, labeled, and capped, as high a rate as 60 bottles (30 gallons) per minute are turned out.

New Material

A large number of machines have been perfected on the West Coast to take advantage of the ready made market. The John T. Raisin Corp. of San Francisco has recently announced the development of an automatic machine which forms boxes for food packaging from precut blanks without the use of glue or special locking tabs.

The secret is a special coated cardboard. The coating may be one of the vinyl films, or a foil.



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Normal/abnormal . . . high/low . . . go/no-go: these are important decisions being made by A.P.I. Very High Sensitivity Measuring Relays.

Direct from sensory elements or circuits, the A.P.I. measuring relay makes a decisive "yes or no" decision on the basis of very close-tolerance voltage or current changes. In typical, critical applications, this measuring relay is saying "yes or no" on a change of ±1 microamp; or in a 400- to 500-volt circuit, on a variation of only a few percent.

Moreover, the relay is capable of actuating on very tiny currents: for example, total inputs as small as 0.2 microampere or 0.1 DC millivolt. It does so without signal amplification, amplifier costs or the signal distortion problems that often go along.

Performance stability is inherent; reliability is exceptional due to the A.P.I. locking-coil design. On "make", contact is firm with substantial contact pressure; contact resistance is low. On "break", separation is clean and quick without contact teasing.

10,000,000 perfect operations is not an all-time record; it's a reasonable expectation of service life.

Widely used for precision switching in computer, control and alarm circuits, VHS measuring relays are practically unlimited in scope of application.

For more information, send for Bulletin 104-D.

api **ASSEMBLY PRODUCTS, INC.**
Chesterland 27, Ohio

The blanks are automatically fed into the machine, which forms the box into shape and applies heat to the corners. The heat seals the box into a smooth and leakproof package, suitable for food which is wet, powdered, or to be baked. It is also suitable for food which must be frozen. The boxes may be from 3 x 3 x ¾ to 12 x 12 x 4 inches in size. It requires only 10 minutes to make a change of size in the machine.

Packaging to Order

Another critical field for packaging is the drug industry. Here again sanitation and quality control are essential. And again, automatic equipment for processing, packaging, and handling has been developed to meet the need.

A major innovation has been the development of the packaging service. This is an interesting concept, particularly well developed in the West, where drug manufacturers tend to be smaller.

The packaging service receives drugs from the manufacturer and handles the complete filling, sealing, labeling, boxing, and packing operation. The rise of these companies has removed the necessity for the small manufacturer to invest a large amount in capital equipment for properly packaging his output.

The packaging company maintains the same high standard of sanitation and exact controls found in the drug company itself. The Packaging Corp. of America, a typical packaging company, has over 100,000 square feet of floor space devoted to drug packaging. There are seven automatic lines for filling liquids, tablets, tubed products, and powdered materials. Two semiautomatic lines take care of multipacks, short runs, and special runs where hand filling is necessary.

Techno-Economics Services, Inc., Los Altos, Calif., have started marketing a powdered detergent which is packaged in a polyvinyl alcohol film. The film dissolves in hot water, freeing the detergent to perform its washing action. The PVA packages are formed in an automatic machine which makes the pillow-type pouches at a rate of more than 120 per minute. The machine then fills and seals the pouch. Packaging is performed by the William Steven Co. of Los Angeles.

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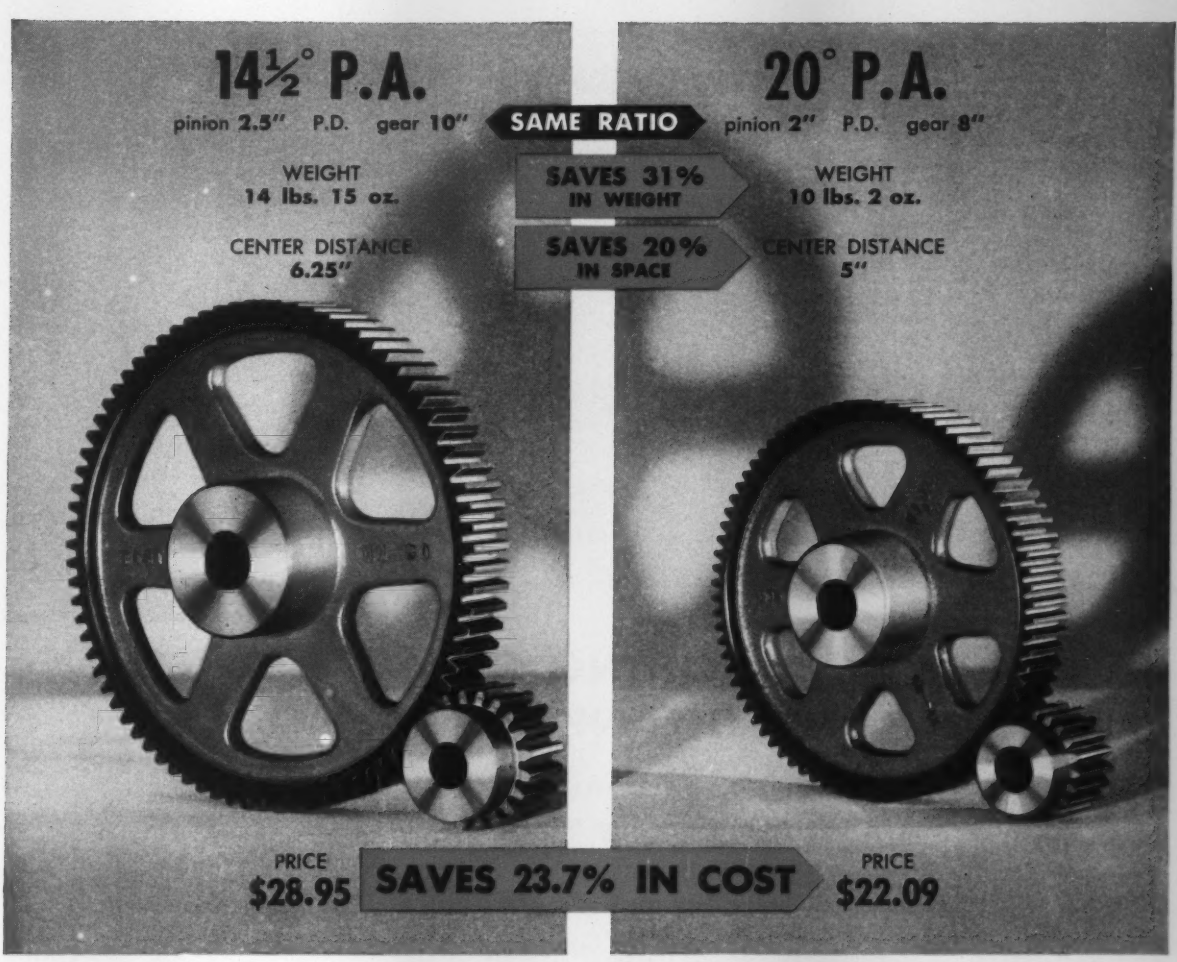

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SPUR Steel and Iron 20 to 4 P.
Fine Pitch Brass 64, 48, 32, and 24 P.

MITER Cast Iron 8 to 2½ P. Steel 48 to 4 P.
Fine Pitch Brass 48, 32, and 24 P.

BEVEL Steel and Iron 20 to 3 P.
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For complete listings see the BOSTON GEAR CATALOG No. 57

Every engineer knows the quiet-running efficiency and high strength of the 20° Pressure Angle tooth form. For most installations, the 20° P. A. Gear that meets specifications saves an average of 20% in space, weight, and cost over the comparable 14½° P. A. Gear required.

Now, the types and sizes of 20° P. A. Gears you need to make these big savings in your assemblies are available, anywhere in industrial U.S.A. and Canada, FROM STOCK at over 100 conveniently located BOSTON GEAR Distributors.

Your local Distributor's factory-trained gear specialist is at your service. Get details. Start *making* the savings you've been missing. Boston Gear Works, 95 Hayward St., Quincy, Mass.

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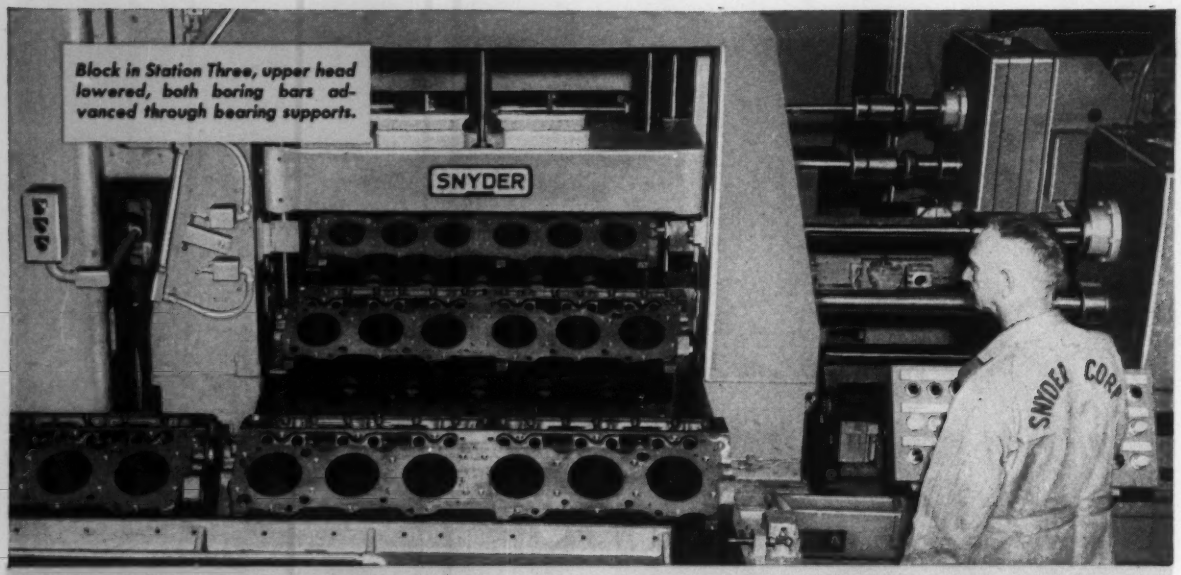
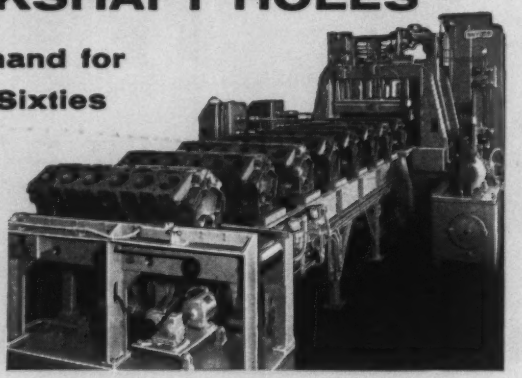


Block in Station Three, upper head lowered, both boring bars advanced through bearing supports.

PRECISION BORING OF 42" LENGTH CAM AND CRANKSHAFT HOLES

SNYDERIZING Meets the Demand for Quality Parts for the Soaring Sixties



This 12-cylinder block is for heavy duty truck and marine engines aimed at taking a bigger bite of this booming market. Our Snyder special 7-station machine is helping this manufacturer SNYDERIZE for the Soaring Sixties by providing boring tolerances which make his product outstanding.

In regular production at a rate of 31 pieces per hour, main and camshaft bearing holes are rough and semi-finish bored simultaneously with all diameters held to manufacturers' specifications for alignment, roundness and concentricity. The distributor hole is also semi-finish bored in this machine to establish proper location to cam and crank bores.

Advanced engineering, both in product and production machines, is the best possible preparation for the competition of the next decade. We'll be happy to show you, too, how to SNYDERIZE for the Soaring Sixties to gain more efficient parts handling, gaging, assembly and machining. Write or phone for new brochure on machines for profit improvement.

Standard Features of Snyder Machines

1. SNYDER UNITS equipped with hardened and ground steel ways.
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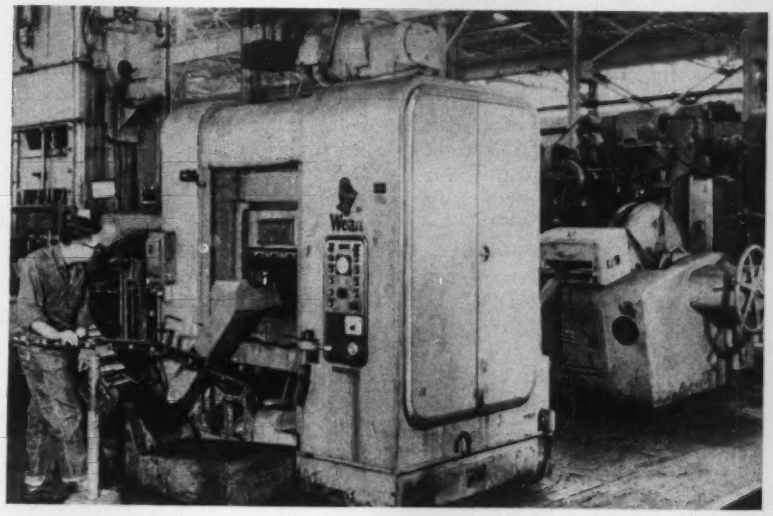
By JAMES C. KEEBLER Managing Editor



Wean Flying Press is turning out transmission vanes at Chevrolet's Cleveland stamping plant. The vanes, 3¾ inches long by 1⅝ inches wide, are blanked out of 0.042 inch steel strip and formed through a seven-stage die. Previously produced by two conventional presses, each operating at 154 strokes per minute, the combined production is more than equaled by this single Flying Press operating at 350 strokes per minute. A mechanism receives the vanes from the press and nest-stacks them for maximum ease of handling.

Co-op Engineering

ALTHOUGH the critics of Detroit engineering have been known to be vocal on almost every part of the product the authorized dealer has for sale, it is rare indeed that the automakers take a back seat to anyone when it comes to manufacturing techniques.

Admittedly the manufacturing engineers have an advantage over the product engineers in this regard, because the results of the process planning efforts are not ordinarily available for evaluation by the man on the street, whereas there is always open season for pot-shooting at "the dolt that designed this bucket of bolts."

Important Job

One reason why Detroit's manufacturing techniques are above par for some other industrial shops is that the auto industry has long recognized the critical importance of having top-notch process men establish the production sequences and specify the equipment.

Perhaps a clue to the relative invulnerability of the manufacturing engineer is that he doesn't have to go it alone. There are vast legions of equipment builders who provide manufacturing engineering *To* industry as part of the job of hawking their wares.

Engineering Sources

The amount of useful manufacturing engineering know-how that can be obtained from an equipment builder depends to a great extent on the attitude that company's management has toward the building of special-purpose machines as opposed to selling only standard catalog equipment.

The builder who is willing to make specials is likely to amass a wealth of talent at solving manufacturing engineering problems, whereas the organization that frowns on this practice is likely to develop the attitude that they have something good for sale to anyone who is smart enough to figure out how to use it. Where this attitude exists the customer is on his own so far as manufacturing engineering is concerned.

Certainly the ranks of the vendors are not divided only into these two extreme camps. Most occupy a middle ground somewhere in between. The pros and cons of the extreme positions make either stand hard to maintain.

If the attempt is made to sell only standards, the builder has few debugging worries, but when industry stops building new plants and expanding facilities the sales evaporate. If the builder designs special equipment to solve manufacturing problems, there may always be a large market potential, but this may be fraught with too many unexpected bugs that eat shirts.

There is no doubt much to be said for the middle of the road position. If a project can be blessed with a happy combination of manufacturing engineering know-how from similar products contributed by the manufacturer's process men; plus the know-how of equipment suppliers in a certain type of process, it has a better chance of success than if either attempt to tackle the job without the co-operation of the other.

Generally the automakers are experienced enough in this co-operative approach that their innovations in manufacturing have a high rate of success. The automater must keep his eye out for new equipment developments that have a potential in his shop, because he recognizes this as one of his company's avenues to achieving a competitive advantage. When these new developments are put to work, they perform best if both buyer and seller have put something into it that makes this job uniquely better than similar previous installations.

For Instance

The Wean Flying Press represents a good example of this approach to manufacturing engineering. A machine builder, Wean Equipment Corp. built its business on the sale of equipment for the processing of coiled metals.

In September of 1954 their Albert

J. Sarka (now director of research and development) came up with the invention of the Flying Press.* In the role of Wright Brothers of the Flying Press, Sarka not only supplied the practical concept of the machine, but also played a major part in getting the contraption off the ground.

To date more than 60 of these presses have been built, with about half of them going to the auto industry. The name Flying Press is not meant to designate the equipment as airborne, but rather to get across the idea that various kinds of presswork (shear, pierce, blank, form, draw, and bend) can be accomplished on the coil stock while it is on the fly through the press.

Generally the stock is fed from an uncoiler through leveling rolls and a pinch type roll feeder that is synchronized with the press. The principle of action of the platens is such that the dies come in contact with the stock while both are moving from back to front of the press. No brake or clutch is required because no part of the machine need be stopped and started as part of the operating cycle.

This arrangement is not only a continuous-non-stop process, it is a fast one too. Speeds of 350 strokes a minute performing operations on stock moving through the press at feeds in excess of 1800 inches per minute are being accomplished.

It is interesting to note the variety of Flying Press applications. Some use it primarily as a shear so that they can take advantage of material cost savings in buying coils and cutting them into sheets rather than buying sheets. In such cases Wean's experience with other coil equipment comes in handy and they are able to take responsibility for the whole line from ready stand to stacker.

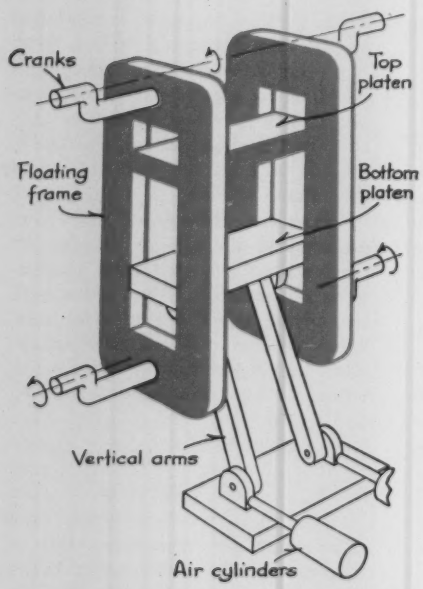
Another application included tie-in with a stock butt-welder and looping arrangement so that new coils could follow old without stopping the press which was tied into a subsequent roll forming operation.

By tackling different types of manufacturing problems, Wean engineers have put the Flying Press principle to work in various shapes and sizes. A notable version has three cranks on an A-shaped floating frame in an open-side model. This job powers the cranks with levers instead of gears. Miss-cutting, sheet feeding, and scrap chopping are all part of the Sarka repertoire.

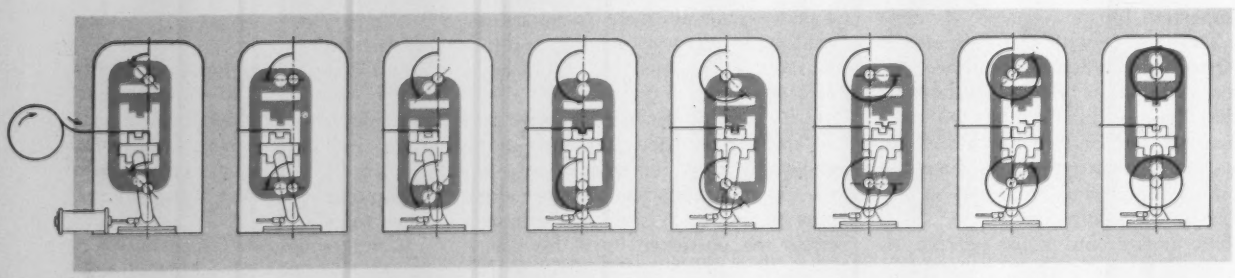
Automation Emphasis

Each of these applications shows that this significant development, embodying all three phases of automation emphasis (process, handling, and control) is not just a tooling improvement but an adaptable-integrated production process. As the manufacturing engineers *In* industry pool their know-how with the manufacturing engineers *To* industry their combined talents surely bring forth new cost saving manufacturing methods.

*"Flying Press—Stamping on the Run," AUTOMATION, Vol. 2, No. 8, p. 8, Aug. 1955, and "Automated Presswork," AUTOMATION, Vol. 3, No. 12, p. 29, Dec. 1956.

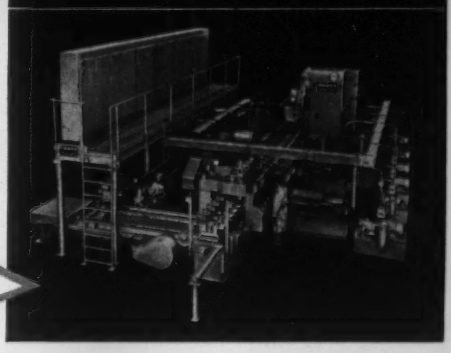


In the Wean Flying Press a floating frame is mounted on cranks (or eccentric cams) which are linked (by gears or levers) such that they rotate in the same direction at the same speed. Thus all points on the floating frame describe a circle of identical size during each revolution of the cranks. Press platens are mounted in ways in the floating frame. The top platen is fixed-adjustable to accommodate different die heights, but during the press cycle has no motion relative to the floating frame. The bottom platen is free to slide up and down with respect to the ways of the floating frame, but is constrained in its movement with respect to the outside frame of the machine by vertical arms which allow the lower platen to describe an arc whose center is the lower pivot point of the arms. The point of tangency of the circle described by the top half of the die and the arc described by the lower half of the die corresponds to the bottom-dead-center position of a conventional press. The back-to-front portion of the arc motion of the lower platen is synchronized with coil stock feed to enable the dies to strike the stock on the fly. Generally crank speed is adjusted by rheostat control of dc motor drive, and feed of stock is synchronized by dial control of a P.I.V. gear drive. Miss-cut is accomplished by air cylinders moving the lower pivot of the vertical arms out of alignment with the upper platen, thus preventing the dies from coming together during that cycle. This device is interlocked with a sensing arrangement that detects stock misfeed or hang up in the dies (resulting in what is known as "cobble" between feeder and press) and prevents damage by not hitting in this condition and subsequently shutting off the press.



Installed view of FAWICK CB Airflex Clutches, 16 of which drive 40 spindles with a disengage-retract-engage-drive sequence. Units conform to JIC standards, require only routine inspection and preventive maintenance.

CROSS Chucking Transfer-matic, an outstanding example in machine tool automation. Each of three Transfer-matics at Ford's Sterling plant turn and bore differential cases at a rate of 368 pieces per hour, with the work pieces chucked and not released until all operations are completed. They operate 16 hours a day, 5 days a week.



Fawick Clutches here... provide precision automation HERE!

■ Sixteen FAWICK CB Airflex Clutches provide the precision power-transmission link between driving members and 40 driven spindles. In this outstanding automated operation of the Cross Chucking Transfer-matic, FAWICK Clutches automatically disengage and retract from the driven drums at the end of each cycle. As the work pallets are indexed, the clutches engage and drive the next cyclic set of spindles. All operations and transfer of pallets to their new stations are simultaneous.

This installation is another example of the flexibility that FAWICK clutches provide to industry. *Instant response, lifetime "new clutch" action, full power transmission, greater operating safety and freedom from maintenance* are all "automatic" advantages supplied by FAWICK Clutches.

For detailed information contact your nearest FAWICK representative or write to the Home Office, Cleveland, Ohio.

FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
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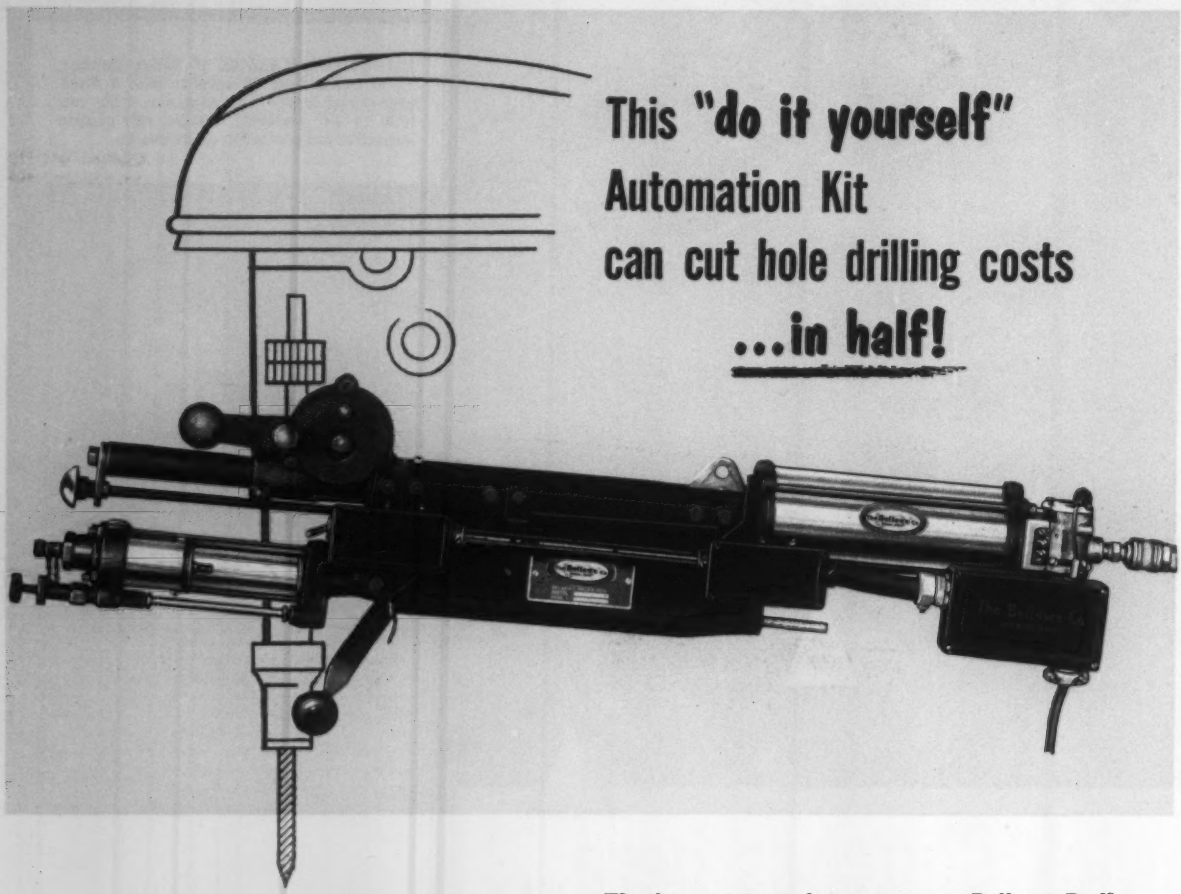
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

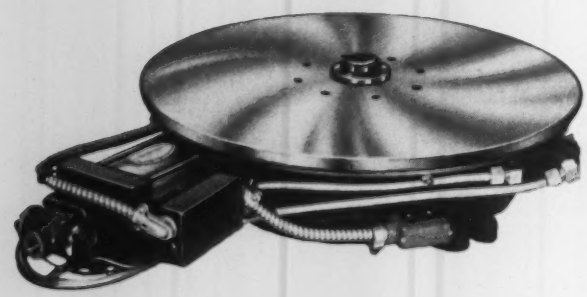
FAWICK AIRFLEX

FAWICK AIRFLEX CLUTCHES • AIR RING BRAKES • ROTORSEALS • SAFETY CLUTCH CONTROLS

Circle 681 on Page 19



This "do it yourself" Automation Kit can cut hole drilling costs ...in half!



The kit consists of two units: a Bellows Drill Press Feed which attaches to the star wheel shaft of a drill press and feeds the spindle automatically; and a Bellows Rotary Feed Table which positions parts under the spindle and removes them automatically.

These two "automation" production units can turn almost any standard drill press into a high speed automatic machine. All the operator has to do is load and unload the feed table. Easily adjustable controls permit precise regulation of feed rate to fit the needs of any tool working in any material.

Your own tool room people can make the installation quickly. The total cost rarely runs more than the wage cost of a single operator for a few weeks. And the chances are good your savings will offset the price even before our bill is due.

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1124-B

The Bellows Co.

DIVISION INTERNATIONAL BASIC ECONOMY CORPORATION

AKRON 9, OHIO

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Compatibility

According to Webster's, any group of elements are compatible if they are "capable of coexisting in harmony" with each other. Successful integration of an automated system requires agreeable and harmonious functioning of all the elements—machines, handling devices, and controls. This applies whether the system comprises a sequence of steps in a single machine or a complete series of processing operations.

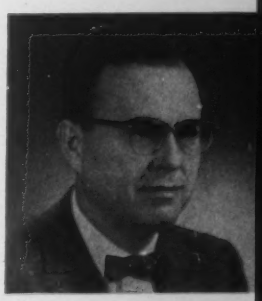
Recognizing this vital need from firsthand experience with automated systems, manufacturers have been gradually adopting one of two solutions: in-plant design of the automated facilities, or purchase of complete systems integrated by a single supplier. These trends have been significant, especially with systems involving higher level, more sophisticated controls.

Noteworthy in this regard are the activities of many standards organizations. An example is the fact that NEMA has formed a new Industrial Automatic Systems Section whose responsibility will be to develop standards defining parameters of performance of systems and dynamic performance of components or parts used in control systems.

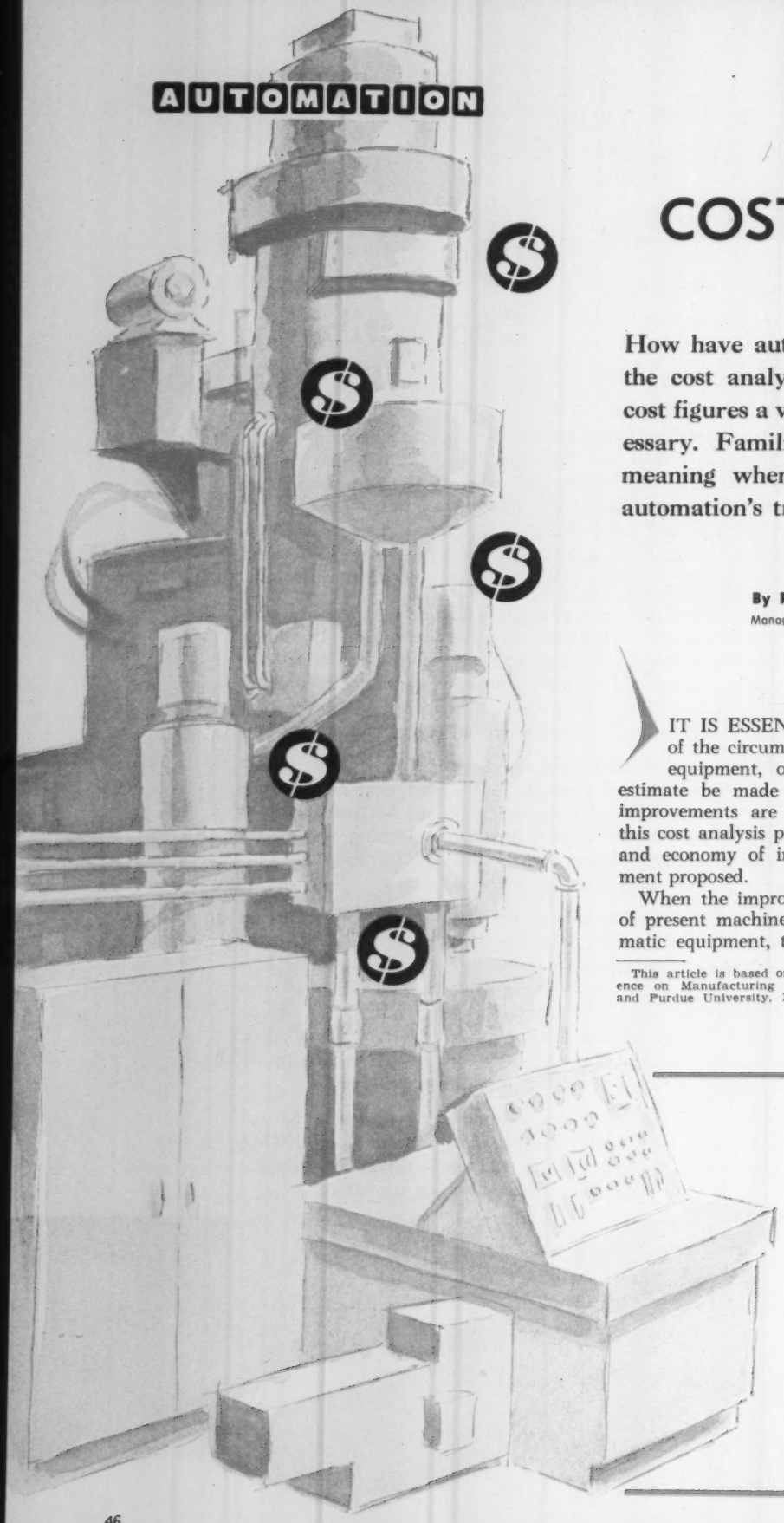
Scope of the Section will cover definitions, compatibility of components and performance standards with equal attention to such important factors as service life, reliability, component spacing standards for low-voltage systems, and environmental conditions. The aim, "to establish rating and variety of use standards for the mutual benefit of manufacturers and users; to facilitate selection of appropriate components and to enable their repetitive manufacture," is highly commendable.

Compatibility of system components, regardless of size or character, is a basic requirement of automation. NEMA standards activity can make a significant contribution in the area of industrial automatic manufacturing operations.

EDITOR



AUTOMATION



COST ANALYSIS

How have automatic processes changed the cost analysis picture? For realistic cost figures a whole new approach is necessary. Familiar factors take on new meaning when viewed in the light of automation's trends.

By **ROBERT A. LOWE,**
Managing Partner, R. A. Lowe & Co., Willoughby, Ohio

IT IS ESSENTIAL that an analysis be made of the circumstances surrounding any method, equipment, or process improvement and an estimate be made of the savings expected, before improvements are undertaken. Management uses this cost analysis procedure to judge the desirability and economy of investing capital in the improvement proposed.

When the improvement involves the replacement of present machines through the purchase of automatic equipment, the factors involved in determin-

This article is based on a paper presented at the "Third Conference on Manufacturing Automation" cosponsored by AUTOMATION and Purdue University, March 1959.

COMPARISON OF MACHINE REPLACEMENT METHODS

AND MACHINE REPLACEMENT

ing the savings become of new importance. The high initial cost, technical complexity, and far reaching effect of automatic processing are changing today's cost analysis concepts.

Economists report that during the latter part of 1958 capital spending for new equipment hit the lowest point in nearly fifteen years. In addition, we are told that plans covering the next two years do not indicate a return to a spending rate anywhere near that of 1956-57. This, in the face of the fact that more than half of the nation's plants are manufacturing products with equipment which is ten years old or older, suggests that those who are responsible for production must dig deeper for comparative cost facts to substantiate recommendations and sell proposals for mechanization and automation.

Without doubt, much of the decision-making behind industry's current plans to curtail the purchase of new equipment, in spite of the age of present machines, is based upon old concepts of payoff and rate of recovery.

In all payoff analyses, direct labor cost is a significant factor. With ever-increasing rates of pay, the average direct labor value of a worker is approaching $7000 (American Iron and Steel Institute reported average hourly wages of $3.314 for November 1958). Management quickly finds that for this amount of money significant steps can be taken toward mechanization. As fringe benefit payments mount and other costs directly related to a worker increase, a mechanization yardstick approaches three times this figure. It is not uncommon to find that managers in industry today feel that they can economically spend $17,000 to $20,000 on new machinery when that machinery requires one less direct labor production worker. This figure is increasing directly as wages and fringe benefits are increasing.

For a new payoff analysis, the factors to be considered are still the same. But with an investigation of progress in mechanization and automation, the makeup and value of the factors reflect changing concepts of evaluating savings versus technological advantage. When through the investment of $180,000 it is possible to mechanize a refrigerator door line with the resulting direct labor cost saving of 21 of the 24 operators, how much more investment is economical to do the work of the remaining three and approach the condition of having no direct labor? Or, again, what new values do our cost factors assume to provide new meaning to our comparative cost analysis where the alternatives involve moving from an automatic operation having no direct labor, per se, to another fully automatic operation where increased production is the primary benefit of the machine replacement?

Without approaching this discussion from an accounting viewpoint, let us investigate some of the aspects of the change which automatic processing has made in cost analysis concepts. Because of general interest, this discussion will be confined to the

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WHILE control of capital expenditures implies that a company intends to be careful that it does not spend too much for plant and equipment, it also should be recognized that such control will cause management to ask if it is spending *enough* for plant and equipment so that it can produce a quality product at reasonable cost and remain competitive with other companies in the same industry.

The manufacturing engineer is fundamentally concerned with the management of his company's assets because it is his responsibility to develop the most competitive productive assets and to maximize the return on these assets. To do this engineers must bring up to date their knowledge of the techniques of measuring the productivity of capital. The phase of this measurement of most concern is the return on investment analysis based on the facts presented to management when proposing changes in plant, processes, and equipment.

The manufacturing engineer needs to know the implications of each factor and of each method of calculation in use today so that he may rate these proposals. The engineer must approach the evaluation of these factors much as an investment analyst studies them in order to conscientiously choose and recommend between definite alternatives which through detailed economy studies have been reduced to terms of money and time.

There are many methods of figuring return on capital investment in use in today's accounting practice. Most of them are old and fairly simple, but some are more recent and more complex, yet definitely more accurate.

To present a comparison the following hypothetical example is worked out for various methods of calculating the advisability of machine replacement.

consideration of automatic manufacturing processes and the factors involved when a company considers an investment in automatic equipment. The same considerations apply in the chemical, transportation, and communications industries as well as in metalworking. At the same time, electronic data processing and the mechanization of office work is bridging all fields as it adds new emphasis and new yardsticks for cost measurement.

We must leave to others the discussions of the equally important factors involving the over-all economic effects and particularly the far reaching sociological implications of automation. This latter is of greatest importance and its study is developing an all new appraisal of the human resistance to change.

Within the confines of the average factory, however, we are not prepared to consider the global effects of our decisions on the general economy. In a discussion of cost and the changing concepts of cost analysis we will follow the practical approach that a company's prime concern is maximum profit —to insure first survival, then growth and progress.

The subjects of our discussion then are the factors governing a company's selection of alternate methods of producing a product where the decision involves the purchase of automatic equipment, or where advancing technological development indicates that a relatively new automatic facility has become obsolete and should be replaced. Against this background, the accumulation of cost information becomes more critical. As before, the cost analysis must present an accurate picture in order to provide management with factual data by which it can arrive at a decision resulting in maximum profit.

Also, the accounting method assumes new significance (although the accurate accumulation of cost data as well as the type of data needed will be the same regardless of method). New interpretations are necessary in the mathematics of the calculations to properly rate machine replacement proposals as a pure investment and to select the proper method for each type of industry. The time value of money has become a governing factor as the nation's economy advances, and all too frequently proper recognition of this money value is not given today's worth in a payoff analysis. In the past this was not as important when standard equipment was duplicated and a long useful life anticipated. Today, however, automation involves a major investment in equip-

PROBLEM

Replacement of a ten year old standard machine with a special purpose automatic machine.

Cost Factors	Present Machine	Proposed Machine
Labor rate, per hour	2.20	1.90
Production, per hour	60	100
Scrap, average	3%	1%
Annual Direct Material Cost	$32,000.00	$32,000.00
Installed cost of machines	$ 4000.00	$ 7500.00
Resale value of machines in five years	$ 600.00	0
Present Book Value	$ 2000.00	
Present Resale Value	$ 1500.00	
Resale Value one year from now	$ 1300.00	
Taxes and Insurance (% Book Value)	5%	5%
Maintenance and Repairs, per month	$ 20.00	$ 10.00
Lubrication and Supplies, per month	$ 5.00	$ 4.00
Power (0.02/kwh), per month	$ 7.50	$ 17.50
Interest Rate (i)	8%	8%
Income Taxe Rate	50%	50%
Economic Life, in years	5	5
Calculated Annual Operating Cost	$ 6163.00	$ 3468.00

Economic life of five years is selected even though a 15 year life may be minimum in depreciation accounting for income tax purposes. The assumption is made that the hypothetical company is short of working capital and funds for investment in fixed assets are limited to capital recovered through depreciation charges and to profits that can be plowed back into the business.

Particularly for special automatic machines, if the capital invested is to be recovered at all, it is usually necessary that the bulk of it be recovered long before the end of its economic tax life. In such cases companies find it necessary to limit the economic capital recovery period far shorter than the estimated service life that will be required for determining depreciation deductions for income taxes.

The company is assumed to use a straight-line depreciation policy.

ment which has a productive life totally unrelated to either its tax life or its physical life.

Since the accumulation of cost data is generally done on an annual basis and is most familiar to management in an annual cost and return form, the discussion which follows is based on the Annual Cost method of calculating payback. The use of this method will indicate the alternative with the lowest annual operating charges and properly takes into consideration depreciation, cost of money, and income taxes. A company has two kinds of costs in operating any production facility. These are the original investment or capital costs and the continuing expenses or operating costs.

▶ Fixed Costs

The annual capital cost of any piece of equipment is made up of depreciation, which is the annual shrinkage in market value of the equipment as it ages, and the interest charge on the investment that facility represents. Capital cost is based primarily on the following four factors: 1. The first cost of the equipment. 2. The life expectancy of the equipment. 3. The salvage value at the end of its useful life. 4. The rate of return required on the investment.

First Cost of the Equipment—Here a new item of cost appears for automatic equipment. The first cost of new equipment is generally made up of the purchase price of the equipment, transportation costs into the plant, installation on the floor, and tryout. The new cost is *Tryout.* The engineers call it *Debugging.*

Purchase price and transportation are readily determined and usually are fixed outside of the control of the analyst. Due to the size and complexity of new automatic equipment, the installation costs are becoming more frequently of significant value with preparation costs often involving new power requirements, special foundations, and often the moving and rearranging of entire departments to receive the new facility.

The new cost factor of debugging is of major importance in the comparative analysis of the purchase of equipment. The time required, to check out an automatic machine and co-ordinate it into production, multiplies with the degree of complexity of the new facility. In many cases where the machine is

PAYOFF METHOD

Usual practice—3 versions

(a) $\dfrac{\text{Original net investment}}{\text{Initial annual earnings}} = \dfrac{7500 - 1500}{6163 - 3468} = \dfrac{6000}{2695} = 2.23 \text{ years}$

(b) $\dfrac{\text{Original net investment}}{\text{Initial annual earnings after taxes}} = \dfrac{6000}{(2695)(.50)} = \dfrac{6000}{1348} = 4.46 \text{ years}$

(c) $\dfrac{\text{Original net investment}}{\text{Initial annual earnings after depreciation and taxes}} = \dfrac{6000}{\left(2695 - \dfrac{7500}{5}\right)(.50)} = \dfrac{6000}{598} = 10 \text{ years}$

This is the commonest method used on capital expenditures request forms in every industry today. It is the engineer's rule of thumb method. The investment is divided by the annual earnings (net income from the investment) to give the time needed to break even.

Actually this is not a measurement of over-all return on investment. It tells only how long it will take to get the money back into working capital. The actual return depends on how much is left after the payoff period. The real profitability of a project is determined by how much longer the earnings will continue. A three year payoff project may show an over-all yield of over 30 per cent if it has a long life, but only 12 per cent if it lasts only 4 years, and no yield if it lasts just its 3 years.

Different versions are seen to produce different answers. The common source of difference comes from various concepts of determining *what* the project earns. Choices include: 1. Current earnings or average over the project life. 2. Gross or net after depreciation. 3. Before or after income taxes. 4. With or without interest.

Another major difference can come from the concept of determining *how much* money was invested. Choices include: 1. Current outlay or average tied up over the project life. 2. Gross, net, or average investment.

Advantages. Payoff method is a good risk indicator. It can serve as a coarse screen to pick out high profit projects which are so desirable that they will not require close return on investment measurement, and those that show such poor promise that it isn't worthwhile conducting a thorough study on them. It has a built-in safety factor against the possibility of a short economic life.

Disadvantages. Payoff method rates liquidity as the most important measure of a project. Assuming equal rates of return, long lived capital assets are more profitable than those with a shorter life, but a long lived project with a payoff period equal to that of a short lived project gets an equal rating by this method. The most desirable payoff period is difficult to specify, frequently an estimated or arbitrary choice is used. Good investment opportunities may be rejected by short payoff demands. The most important disadvantage is that the method does not evaluate the profitability of the investment beyond the payoff period. Concentrating on getting the money back into the bank, it overlooks the vital life-pattern of earnings.

Since payoff does not reflect all the aspects of profitability which are relevant to capital expenditure decisions it is inadequate for today's automation management.

the first of its kind ever built by the supplier (as automation often is today) the debugging costs approach 100 per cent of the purchase price. Failure to properly estimate debugging costs has frequently caused severe distress in budgeting for new automatic equipment. In many of those cases, subsequent reappraisal indicated that if a true evaluation of debugging costs had been made originally, the economy of the investment would have appeared in a sharply different light, probably a negative one.

As a specific incident, a plant invested $53,000 in two special purpose automatic machines. On the basis of the investment analysis, the saving was to be $45,000 per year. This was made up of direct labor and an increase in production of approximately 35 per cent over that achieved by the old machines. Indirect savings were indicated in reduced secondary operations and higher quality, but these values were not estimated on the machine replacement proposal.

The machines are now well into the third year of debugging. No period of actual production has yet been realized. Not including time of methods and supervising personnel (who have spent as much as 4½ months, off and on, on the project) the company has spent over $15,000 in debugging. In addition, some $5000 has been expended on unexpected experimental tooling in attempting to put the machines into production.

When this $20,000 figure is combined with the failure to attain the estimated yearly savings, a whopping $155,000 charge is made against debugging—more than three times the purchase price. And the figure does not include "good faith" expenses on the part of the machine builder. The circumstances are not altered when the machine is built completely in the user's own shop, but then the costs are even harder to properly identify.

Life Expectancy of the Equipment—Obsolescence is the primary consideration in the determination of this factor. With rapid strides in research and development, particularly in the plants of equipment suppliers themselves, new improved machines are becoming available almost as frequently as new automobiles. A manufacturer of automatic equipment reported, in the hearings on "Automation and Tech-

RATE OF RETURN METHOD

Usual Accounting Procedure—3 versions

(a) $\dfrac{\text{Initial annual earnings}}{\text{Original net investment}} = \dfrac{2695}{6000}(100) = 44.9\%$

(b) $\dfrac{\text{Initial annual earnings after taxes}}{\text{Original net investment}} = \dfrac{2695(.50)}{6000}(100) = 22.5\%$

(c) $\dfrac{\text{Initial annual earnings after depreciation and taxes}}{\text{Original net investment}} = \dfrac{\left(2695 - \dfrac{7500}{5}\right)(.50)}{6000}(100) = 10\%$

Average Book Value Procedure—3 versions

(a) $\dfrac{\text{Average annual net earnings}}{\text{Average book value}} = \dfrac{2695}{3750}(100) = 71.8\%$

(b) $\dfrac{\text{Average annual net earnings after taxes}}{\text{Average book value}} = \dfrac{2695(.50)}{3750}(100) = 35.9\%$

(c) $\dfrac{\text{Average annual net earnings after depreciation and taxes}}{\text{Average book value}} = \dfrac{(2695 - 1500)(.50)}{3750}(100) = 15.9\%$

This method is in common use and is frequently called the Accounting Method since it is closely related to many of the concepts used in conventional accounting practice. The ratio of the project's annual earnings over the investment is the inverse of the payoff figure.

Here again many variations are due to different ways of expressing the factors of income and investment. This shortcoming can be minimized by standardizing on one variant of the method and measuring all propositions according to this standard.

Advantages. Method yields values that are consistent with the company's accounting figures. Is satisfactory for measuring proposals which have similar factors, or which have similar earning patterns.

Disadvantages. Earnings are considered to be constant or represent the same value for each year of the project life. No consideration is given for the time-value of money and none to the time-shape of earnings. Data are figured over the life span of the project, therefore project must last its expected service-life. When the service-life and the tax-life are different the method is subject to variations. Projects with faster write-offs show disproportionately higher return.

nological Change" before the Sub-Committee on Economic Stabilization during the first session of the 84th Congress, that his machines, ". . . have a useful life of five years, after which continued technological development will bring new improvements in them. The industry is planning on a five year amortization." New materials and processes are likewise coming on the market in increasing variety. These developments, coupled with changing customer demands, force each company to modify its own products to keep up. A basic change in the design of a product may completely obsolete the specialized equipment presently producing it, or force a very costly changeover. The relative inflexibility of automatic equipment must be considered in anticipating its life expectancy. The risk of obsolescence then becomes the determining factor rather than the physical life. Neither are related to its tax life under present income tax regulation.

Salvage Value of the Equipment—Because of its lack of flexibility and frequently its single purpose design, the value of the obsolete automatic machine may approach the true meaning of the word "salvage." Frequently, specialized equipment is completely torn down and standard parts such as motors, gear reducers, air cylinders, etc. are salvaged rather than the equipment sold outside the plant as a production unit.

The estimate of the salvage value of automatic equipment must therefore be very conservative since the useful components may have little resale value.

Rate of Return Required on the Investment—This is the price of the risk involved in purchasing automatic equipment. While as discussed before, obsolescence makes up the larger part of the risk, it is not the only consideration. With all industry approaching a current overabundance of productive capacity, there is active competition to fill that capacity with outside contracts. The consideration of "farming out" the product and investing our money elsewhere merits greater consideration. While it frequently is difficult under modern good management practices to prove greater economy in farming out production, today's high rates for the use

ANNUAL COST METHOD (E. L. Grant)

CALCULATIONS

(a) Annual cost for present machine

Capital Recovery Depreciation	$\frac{1500 - 600}{5}$	=	$ 180.00	
Average interest	$(1500 - 600)\left(\frac{0.08}{2}\right)\left(\frac{6}{5}\right) + 600(0.08)$	=	91.00	$ 271.00
Direct labor	$2.20 × 2080	=	4576.00	
Scrap	0.03($32,000 + 4576)	=	1097.00	
Maintenance and Repairs			240.00	
Lubrication and Suplies			60.00	
Power			90.00	
Taxes and Insurance	0.05(4000 − 2000)	=	100.00	6163.00
	Total Annual Cost			$6434.00

(b) Annual cost for proposed machine

Capital Recovery Depreciation	$\frac{7500}{5}$	=	$1500.00	
Average interest	$7500\left(\frac{0.08}{2}\right)\left(\frac{6}{5}\right)$	=	360.00	1860.00
Direct Labor	$1.90 × 2080 × 0.60	=	2371.00	
Scrap	0.01($32,000 + 2371)	=	344.00	
Maintenance and Repairs			120.00	
Lubrication and Supplies			48.00	
Power			210.00	
Taxes and Insurance	0.05(7500)	=	375.00	3468.00
	Total Annual Cost			$5328.00

CONCLUSION

The proposed machine betters the present machine by $1106.00 annual cost advantage, and should be installed. The $1106.00 represents for purposes of comparison with other methods a 14.76 per cent return on a $7500.00 investment.

This method takes into consideration the cost of money and the time-value of money. No consideration is given for the time-shape of money, however. With depreciation and taxes included in the calculation this is one of the more complex calculations for evaluation of machine replacement, but one of the more accurate. In general the method is excellent.

Advantages. The many factors that enter into engineering economy study are shown on the form. Problems such as purchasing machine attachments, running facilities another year or more before replacement, holding present equipment as standby rather than selling it when new equipment arrives, sinking funds, and other special conditions can find proper evaluation by the Annual Cost Method. The method goes the farthest in developing comparative values for management selection. The factors are treated in terms of annual costs and incomes in a line of reasoning familiar to most management. Tables and charts can be made to offset some of the calculations.

Disadvantages. There are some limitations in the use of the method in comparing projects of unlike characteristics. A predetermined interest rate is required. Some organizations tend to think in terms of fixed costs of money but some minor error is introduced. In some applications of this calculation method an annuity depreciation rate is developed. This is a fictitious figure in accounting practice but is necessary to obtain uniform annual depreciation cost.

of money causes subcontracting to show up in new perspective.

In any case, in today's tight money market, management must not underrate the risk involved in investing in automatic equipment and must compensate fully for that risk in determining the rate of return required.

Analyzing investment in this manner, we are immediately aware that automatic equipment has a higher initial cost. This represents then a higher fixed cost relative to any type of standard machine and points up the heavy load passed along to the piece costs of production. It indicates, too, the necessity of recovering these costs through reductions in the variable costs per piece.

Variable Costs

The makeup of variable costs of operating automatic equipment in production includes the usual items of labor, material, and overhead. Labor includes direct, indirect, and fringe costs. Material includes direct material, supplies, and scrap. Overhead is a composite of maintenance, power, tooling, rent, utilities, insurance, and taxes.

These again are familiar items. But automatic processes are changing the cost analysis concept of some of them, primarily that of labor. When it occurs, the most important factor in our list of variable costs is direct labor. Therefore, the reduction in labor costs appears to be the greatest benefit realized by the introduction of automatic equipment and remains the primary reason that management will consider investing its capital in automatic equipment. In estimating the direct labor cost in operating any equipment, three factors enter the consideration: 1. The direct labor hours per piece. 2. The wage rate per hour. 3. The number of pieces produced per hour.

Direct Labor Hours Per Piece—This is relatively easily estimated, but herein too lies a changing concept. As mechanization increases, the direct labor measuring stick decreases. As more automation approaches, we tend to lose it entirely.

In the major processing industries today, there are no productive workers in the true sense. The process is automatic and the man there is not associated directly with the unit productivity of the plant. He is classified in capacities we are accustomed to call indirect labor in today's accounting practice. None of the older systems for control of labor costs functions here. Work measurement, in-

MAPI method measures how the company would profit with and without the proposed facility. It determines, by analyzing the next year figures, the timeliness of machine replacement. Basic to the theory behind the method is the attempt to help management decide between the alternatives of replacing a machine now or replacing it later. This concept recognizes the constant parade of technological advance.

MAPI method is approximately 10 years old and is steadily coming into broader usage. As first published it was considered too scholarly for the average business man. This greatly slowed down its use. It has been "commonized" in the last year with charts offered to eliminate some of the mathematics and will now come rapidly into its own. The same good basic theory is retained.

MACHINERY AND ALLIED PRODUCTS INSTITUTE METHOD

CALCULATIONS—older, more common version

(a) Present Machine

(1) Next year capital cost ($1500 − 1300) + .08 ($1500) = $320.00

(2) Next year operating advantage:

	Proposed	Present	
Direct Labor	$2205		
Scrap	753		
Maintenance and Repair	120		
Lubrication and Supplies	12		
Power		$120	
Taxes and Insurance		275	
Total	$3090	$395	
Net advantage, proposed machine			2695.00

(3) Adverse Minimum (disadvantage) present machine $3015.00

(b) Proposed Machine

(1) Estimate of Future Gradient $(g) = \frac{2695}{10} = 269$

(2) Adverse Minimum new machine =

$$\sqrt{2eg} + \frac{ie - g}{2} = \sqrt{2(7500)(269)} + \frac{0.08(7500) - 269}{2} = \$2173.00$$

CONCLUSION: The new machine should be purchased because of a cost advantage of $842 in the next year. The $842.00 represents for purposes of comparison with other methods a 11.2 per cent return on a $7500.00 investment.

centives, manning, are all in for reappraisal as old definitions of the direct worker give way as automation changes the cost analysis picture.

Wage Rates Per Hour—Since they are bargainable, these rates are not as readily estimated as direct labor hours. Labor is steadily pressing for higher wages and broader fringe benefits. As automatic equipment is introduced into the plant, labor demands compensation for the increase in production made by the machine and a share of the profits realized through mechanization. Increased unemployment compensation for employees temporarily displaced, lower retirement ages, pensions, increased social security allowances for those too old to learn the new skills to operate the automatic equipment, guaranteed annual wages, and longer vacations for those who are trained to run the automatic plants are routine discussions at the bargaining table. The net effect is an increase in labor costs. This increase must be anticipated and included in the company's estimate of wage rates. To calculate savings by taking today's actual average hourly rate will not give a realistic picture.

As direct labor per piece decreases with the introduction of automatic equipment, the indirect cost of service and maintenance increases. This expense is made up of the cost of material and labor. As in any form of labor, the cost of maintenance labor must be estimated in hours and hourly rates and evaluated against the maintenance hours required to operate the automatic machine.

Here too the pressure to increase wages must be taken into consideration in estimating the maintenance hourly rate. It is an accepted fact that the skill level must be steadily raised as more automatic equipment comes into the plant. The responsibility for training in the skills needed by its maintenance people must be assumed by the company since industry has already exhausted the available supply of these skills on the open market. The cost of these expensive upgrading programs must be borne therefore by the company, and must be properly recognized in the cost analysis of the automatic machine.

While we discuss maintenance labor under the heading of variable costs, we are aware that it is not variable in the same sense as direct productive labor. Changing production patterns does not bring corresponding flexibility in use of maintenance forces and generally a reduction in output on the automatic machine means an increase in relative maintenance costs and therefore higher unit costs.

(MAPI—George Terborgh)

CALCULATIONS—new improved version

(a) Required Investment

Installed cost	$7500.00
Less investment released	1500.00
Net investment	$6000.00

(b) Total next year advantage after income tax

Next year operating advantage	$2695.00
Disposal value decline in year (present machine)	200.00
	$2895.00

Next year advantage × tax rate = 2895(0.50) = $1448.00

(c) MAPI Chart Allowance

Use MAPI chart which represents straight line earnings throughout five year service life—no salvage value.

Chart value is 11%

MAPI Chart Allowance = Installed Cost × Chart Per cent = 7500 × 0.11 = $ 825.00

(d) Amount available for return on investment

Total next year advantage after taxes	$1448.00
Less MAPI Chart Allowance	825.00
Amount available for return on investment	$ 623.00

This is annual savings after taxes favoring replacement now.

(e) MAPI Urgency Rating

$$\frac{\text{Available for return on investment}}{\text{Net investment}} = \frac{623}{6000}\ (100) = 10.4$$

Advantages. The method is considered by industry observers as one of the really significant management techniques in equipment proposal evaluation. Provides "Urgency Factor" which compares return on investment with the net investment required. The improved version with its charts covering compound interest calculations, tax depreciation, earnings, and patterns makes the method far easier to apply among the new complex methods available.

Disadvantages. One of the dangers of simplified application techniques is that the method may be applied by people unfamiliar with the background theory to circumstances inconsistent with the thinking on which the charts were based. The assumption that history will repeat itself can be a disadvantage.

Even on the long term basis a company will be reluctant to lay off maintenance personnel who have acquired the new higher skills. Realistic cost figures must recognize the effect of this difference.

Number of Pieces Produced Per Hour—The more pieces produced per hour, the more attractive mechanization becomes. The automatic machine will recover management's investment as planned, however, only when it maintains full production. This suggests another changing concept in cost analysis.

Companies that are in the stages of operation and process mechanization rather than product automation face added problems in economical machine usage. Many times production problems are solved in a trouble spot through mechanization only to precipitate added problems further along in the productive sequence. Until those bottlenecks are also broken, new automatic equipment cannot operate at effective production levels and very expensive downtime costs may be incurred.

This all too familiar occurrence calls attention to the basic fact that a complete study of *all* the circumstances surrounding the manufacture of the product is demanded in integrating an automatic machine into the sequence of operations to attain and maintain maximum usage and therefore rapid payoff. This detailed study will bring out further opportunities for the use of the facility beyond those planned and evaluated originally. It often brings out side effects too, which may alter the viewpoint on the entire proposal.

The study should include a review of the design of the company's complete line of products. Adapting component parts of other products for production on the new facility will supplement the parts originally intended for the machine and actually may accelerate the planned payoff period.

Maximum simplification and standardization is always necessary in good production practice; the advent of expensive automatic processing is simply forcing a greater degree of consideration of these factors. Sometimes the detailed study calls for a complete reappraisal of the actual need of the machine itself.

It has not been unusual to find that the analysis, simplification, and standardization of work methods in preparation for processing on a new facility has yielded the major savings anticipated in the overall planning for the installation of the automatic equipment.

Several recent cases involving the installation of electronic data processing have served to sharply point up this condition. When the records and procedures were converted for processing on the equipment, the savings realized were so substantial that the processing equipment would either not have paid for itself out of the balance as anticipated in the original cost analysis, or may have been much more difficult, if not impossible, to sell to management in light of its specific savings contribution. Here is an example of a not uncommon experience.

A large midwest appliance parts supplier with

CASH FLOW-BACK METHOD (Joel Dean)

CALCULATIONS

Year	Income before Depreciation	Depreciation	Cash Flow-Back after Taxes: on Income	Cash Flow-Back after Taxes: on Depreciation		Total after Taxes: No Interest	at 12%	at 13%
1	$2695.00	$1500.00	$1347.50	$750.00	=	$2097.50	× .893 = $1873.07	× .885 = $1856.29
2	2695.00	1500.00	1347.50	750.00	=	2097.00	× .797 = 1671.71	× .783 = 1642.34
3	2695.00	1500.00	1347.50	750.00	=	2097.50	× .712 = 1493.42	× .693 = 1453.57
4	2695.00	1500.00	1347.50	750.00	=	2097.50	× .636 = 1334.01	× .613 = 1285.76
5	2695.00	1500.00	1347.50	750.00	=	2097.50	× .567 = 1189.28	× .543 = 1138.94
						$10487.50	$7561.49	$7376.90

Interpolating: $\frac{7561.49 - 7500}{7561.49 - 7376.90} = \frac{61.49}{184.59} = .33 \ldots$ Add .33% + 12% = 12.33% Return on Investment

Pay Out period is the cash flow-back after taxes to the point where the cumulative total equals the $7500 investment.

This occurs between the third and fourth years on the cash flow-back chart. The exact point where the money invested has returned is $1207 into the fourth year for a 3.58 YEARS Pay Out.

This method is sometimes called Cash Discount Flow. In this method, a present worth factor is determined.

$$f = \frac{\text{Immediate cash flow (out)}}{\text{Recurring Annual Cash Flow (in)}} = \frac{7500}{2695} = 2.78$$

Interest rate from annuity tables (5 years) = approximately 23.4%

This is equivalent return on investment before taxes

an inventory problem embarked on a computer installation in which the cost study indicated a direct labor savings of 34 people. In shaking down the paperwork, eliminating unnecessary work, leveling work loads, developing processing standards, and itemizing jobs in preparation for processing by the machine, it was found that the work force was reduced from 46 to 26. The installation of the computer further reduced the force from 26 to 12, a substantial reduction but a lesser savings than the cleanup of existing practices.

In the complete study, the company should review its sales promotion policies. The automatic equipment will put more product into the hands of the sales department quicker. This added capacity for customer service may increase sales and improve production volume. The addition of automatic equipment frequently shifts the pressure of economic production from manufacturing to sales.

The study may find that increased volume and production and income is possible specifically due to the automatic equipment. A change in the company's profit policy may be indicated where it is possible to pass some of the savings along to the customer in lower selling prices and thereby increase sales and volume production. While smaller profit per piece is realized, the net results may be greater profit for the company.

We read today that this latter approach is indicated in industry's evaluation of today's markets. Recent surveys show that greater sales at lower profits are in management's current planning. Successful operation under this formula, however, requires full production and brings still greater emphasis on maintaining our planned levels of usage of our automatic equipment.

▶ Secondary Cost Factors

In addition to the primary factors discussed above, there are very important secondary factors which affect cost analysis. Although secondary, the effect they have is very real and must be considered in any realistic comparative analysis. In addition, they are assuming steadily increasing weight in the consideration of machine replacement and are probably the motivating forces behind the changing cost concepts. These secondary factors are higher quality, less material handling, less supervision, reduced inventory, and improved working conditions.

One particularly stands out because of the recent business recession. This factor is the effect of the introduction of automatic equipment on inventories. Because of the shorter production time cycle realized from the equipment, raw material, work in process, and finished product inventories may be controlled to significantly reduce investment of working capital while at the same time providing increased customer service. Coupled with the computer for instantaneous inventory control, the combination may well affect the entire economic position of inventory investment on future balance sheets.

The redesign of component parts to adapt other products of the company for processing on the automatic equipment likewise reduces the variety of parts inventories. Savings in warehousing, floor space, and handling, as well as the benefits resulting from less frequent, larger quantity purchasing of materials, are of real value and enter into the cost analysis.

Another important secondary factor is quality control. The reduction in scrap resulting from the built-in automatic control of quality is a very posi-

This method is sometimes called Discounted Cash Flow, Profitability Index, or the Investor's Method. It treats equipment investment in a most advanced manner because of its continuous compounding of interest and present worth factors.

It discounts the cash flow back from the investment over the years until it equals the present worth of the investment. The mechanics of the method consist essentially of finding the interest rate which discounts future earnings of a project down to a present value equal to the project cost. A tabulation is prepared covering all income and expense expected to occur over the life of the investment. The entries are extended by compound interest rates until the present worth of that series of income equals the investment. The discount rate which yields this equality is the rate of return on investment.

If it is considered that money placed in other investments would probably behave according to that pattern, this method is seen to show a very valid return on investment factor.

In the Cash Discount Flow example, earnings are stated as gross receipts (not figuring depreciation). Therefore, it is not necessary to allocate the cost of the machine over its lifetime before computing return. Depreciation is allowed for automatically because the interest rate that discounts the sum of present values to zero is the rate of return on the investment after annual provisions for repaying the principal amount.

Advantages. This is the most flexible method. Time of investment, status of project, unlike alternatives, adding or subtracting facilities are easily accommodated. It takes care of incomes and expenditures as they occur, handling any amounts of money spent before projects start, or while they are active, as well as funds returned after project completion. The rate of return on investment figure takes into consideration full-life characteristics of the project enabling an evaluation of differences between proposals in the precise time shapes of future earnings. It appears to best answer the question, "Will it pay?" and as such may become the most used method for equipment analysis.

Disadvantages. One of the disadvantages lies in the difficulty of accurately forecasting income and expenses far into the future. The effect of error diminishes with time, but does exist. The income forecast is generally inconsistent with accounting practice too, and the profits anticipated will seldom show up in the company's books that way. The method does have a weakness in that it provides only one rate of return throughout the life of a program. Actually plant investments do not behave quite like that—but that is a whole new discussion which is outside the range of this study. However, slow starting programs are at a disadvantage as measured by this method.

tive saving. With the increased use of feedback and self regulation, the automatic equipment is less capable of producing unacceptable pieces.

Statistical quality control has taught us that the actual realization of good production under many specifications is possible *only* with automatic equipment. SQC changed many old beliefs concerning acceptable production, and scrap cost beliefs changed along with them.

In tolerance and accuracy requirements new aircraft and missile programs are demanding such critical control that the creation of scrap is of paramount importance. For example, a jet turbine shell is worth today's price of an average new home when it goes to the tape-controlled machine for drilling the blade root diameters. Until this automatic equipment was developed, the part was frequently scrapped in drilling. While this is a spectacular example, the savings resulting in scrap reduction in the use of automatic equipment in all cases is very real and important in our analysis.

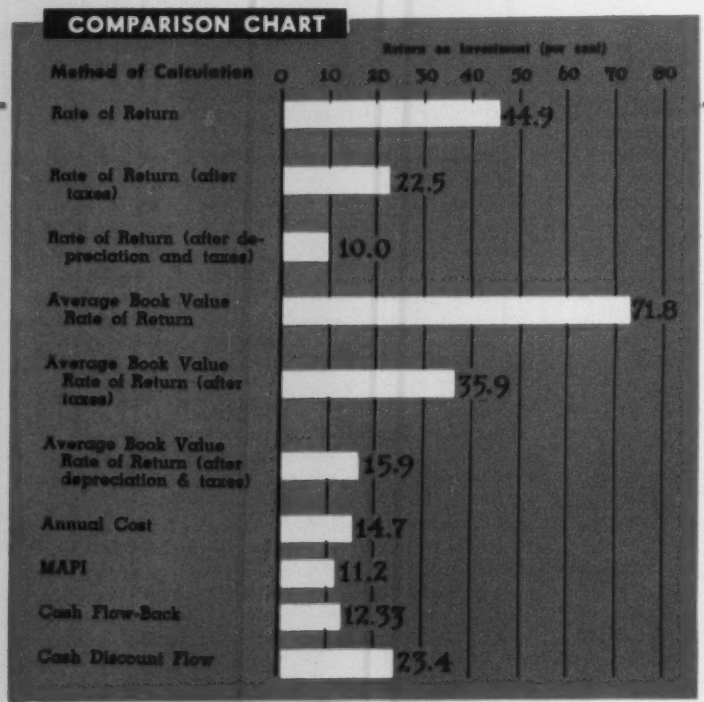
Material handling is another important secondary factor. Automatic equipment generally consolidates operations, frequently is self loading and unloading, and often transfers the work between processing stations. The resulting savings in handling costs are again real and important in the analysis.

In the case of working conditions, we long have recognized that automatic equipment lessened the drudgery for the individual worker, increased his safety and his physical comfort. In personal safety, automatic equipment has converted historically unsafe processes into accident-free remote-controlled production lines. Most of the automatic processing lines are becoming totally accident-free.

For example, there are now whole new industries in existence such as atomic energy and isotope technologies which by the very nature of the materials handled could never have been possible by hand methods and close human contact. The automatic process brought safety to these industries. The decision to purchase automatic equipment under such circumstances could not be made on the basis of the old cost measurements. Here the new cost concepts have maximum value, but they are of measurable value and weight in the evaluation of all automatic processing.

In review, the factors considered are the same as have always been used in the economic evaluation of any cost reduction program. The coming of automatic processing is bringing a new identification to those factors, however. As some of our old stable yardsticks are disappearing and as those remaining are changing both in importance and meaning, new interpretations are necessary in developing true figures for modern cost analysis.

It is no longer realistic to consider automatic equipment only in terms of replacing the worker and returning the investment in six months or one year. Today the purchase of such equipment is approached from the viewpoint of productivity and quality. This change in attitude is stimulated by the pressures of competition and technological advance. The trend of progress of the whole industrial organization is accelerating. Each company's chances of keeping up, avoiding obsolescence, and maintaining a competitive position demands this whole new approach to economic cost analysis.

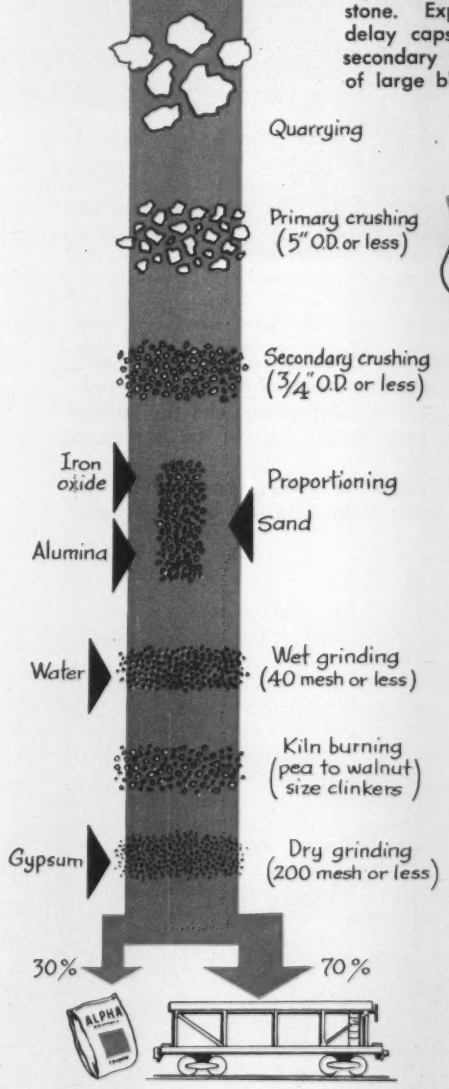


Comparison of results obtained from some of the basic methods of determining return on investment shows that consistent evaluation can be made when comparing various results only if the same basic method has been used to obtain those results.

Management wants to know in advance if a proposed equipment installation will pay. Any valid method can rate the proposed equipment against the present or other alternate equipment and tell which will pay more. The answers to the questions of HOW will it pay? and WHEN will it pay? require the more sophisticated methods.

These answers are concerned with precise time-shape values of future earnings, and manufacturing management is trying to measure them accurately in advance in order to make the best choices between alternative opportunities, and put money in sound investments.

1 Conversion of limestone into cement at the Alpha Portland Cement Co. starts at two quarries which furnish the basic raw material. Excavating equipment first strips away top soil, stone, and rock to a depth of 5 to 25 feet to get at the main bed of limestone. Exposed rock is then drilled in many places and blasted with millisecond delay caps which allow a split second delay between each small charge. When secondary breaking is required, a 6000-pound drop ball is used to reduce the size of large blasted rocks to convenient trucking sizes.



AUTOMATION TODAY

MASS HANDLING— KEY TO EFFICIENT

MANUFACTURE OF PORTLAND CEMENT

THREE necessities for the profitable operation of a cement plant are the nearness of limestone quarries capable of supplying basic raw materials for an extended length of time, a market within a shipping distance of 150 miles which is capable of absorbing the total production of the plant, and an up-to-date plant to keep operating costs at a minimum. A combination of nature and market studies are sufficient to fulfill the first two necessities and pin-point the location of a plant, but the third factor requires careful engineering and full use of as many automated facilities as possible.

A case in point is a recently completed plant of Alpha Portland Cement Co. at Lime Kiln, Md., which produces all standard types of portland and mortar cements by the wet process. The plant was built by the MacDonald Engineering Co., Chicago,

2

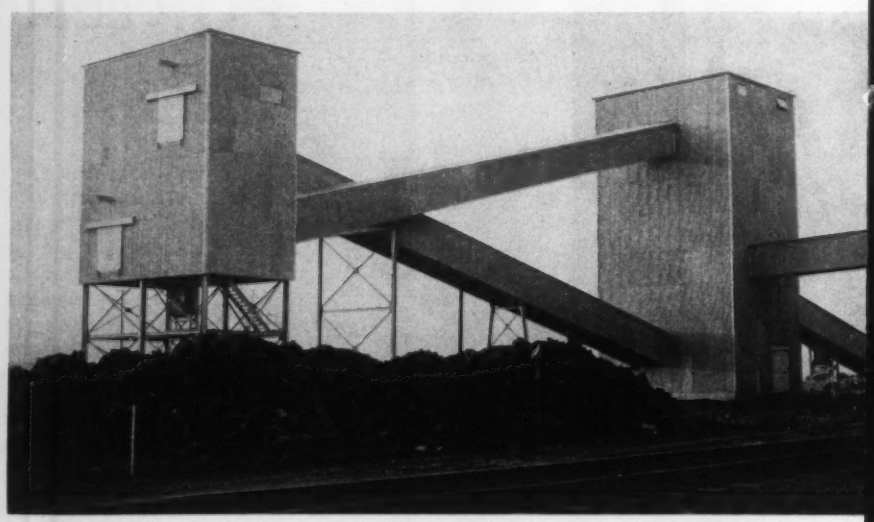
Fleet of 17-ton trucks hauls the quarry rock to the primary crusher building at the main processing plant. Broken rock is loaded by two electric shovels, each capable of handling 7500 pounds of rock with each scoop. At the primary crusher, the trucks dump their loads onto a vibrating feeder which screens out pieces less than 4 inches in diameter and feeds larger stones to a jaw crusher. After being reduced to a size of 5 inches or less, the crushed rock joins the screened rock and is moved by conveyor to a secondary crushing station.

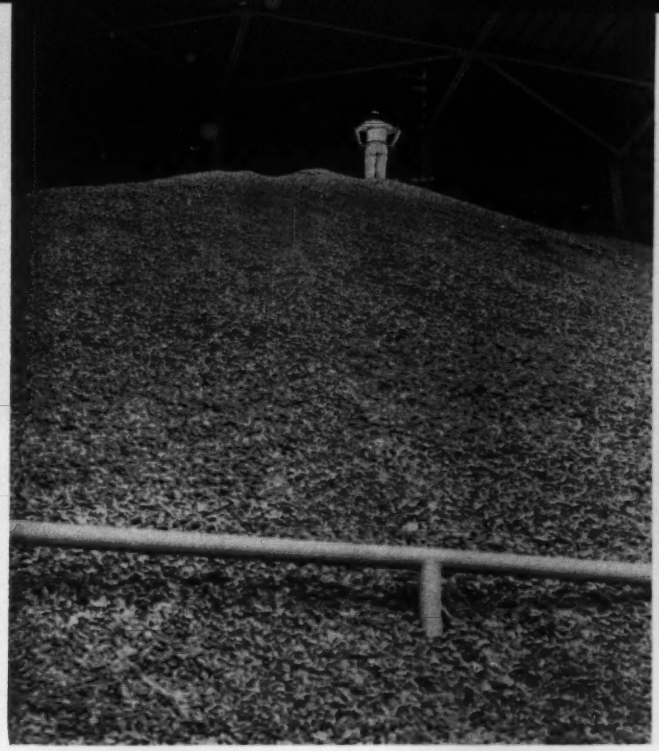
and is located on a 1000-acre tract of ground containing enough raw material—limestone—to last for 100 years at peak annual production of 2.25 million barrels of cement. Output of the cement plant is earmarked for ready-mix concrete plants, concrete products plants, dealers, and contractors within a shipping distance of roughly 150 miles which includes markets in Baltimore, Washington, and Richmond, Va. Approximately 70 per cent of the finished product is bulk shipped via railroad car, and the facility is serviced by a main freight line of the Baltimore and Ohio Railroad.

Up-to-date facilities have been provided by an investment of more than $100,000 in plant and

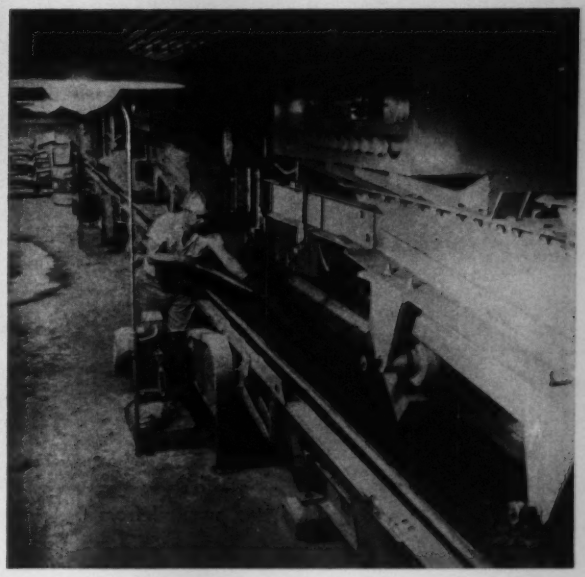
3

Sloping, enclosed conveyor at far right moves the crushed rock from the primary crusher building to the screen house where an impactor reduces 90 per cent of the stone to ¾-inch size or less. The material is then discharged onto a set of double-decked screens which screen out all pieces over ¾-inch size for return to the impactor and further crushing. Stones passing the screen mesh are conveyed to a covered plant storage area by the horizontal covered conveyor leading away from the screen house at the right. The crushing plant is designed to handle an average of 350 tons of rock per hour.

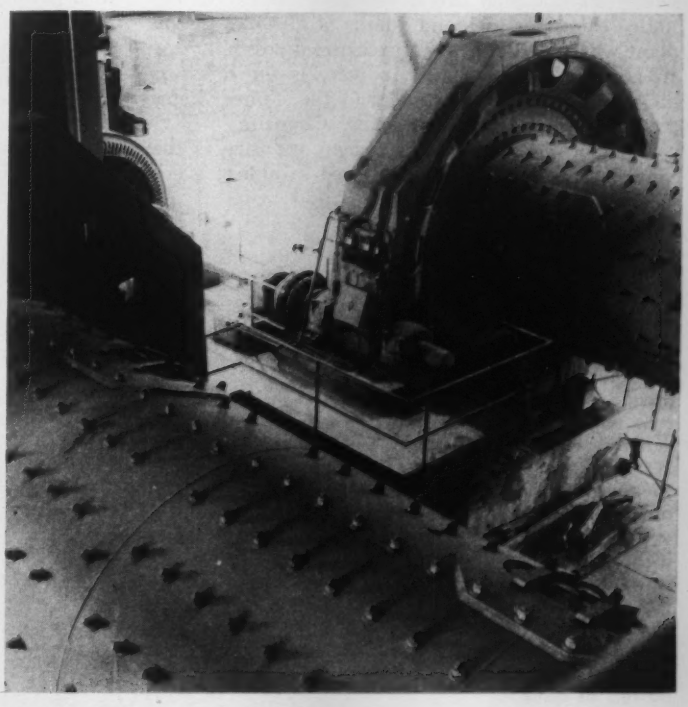




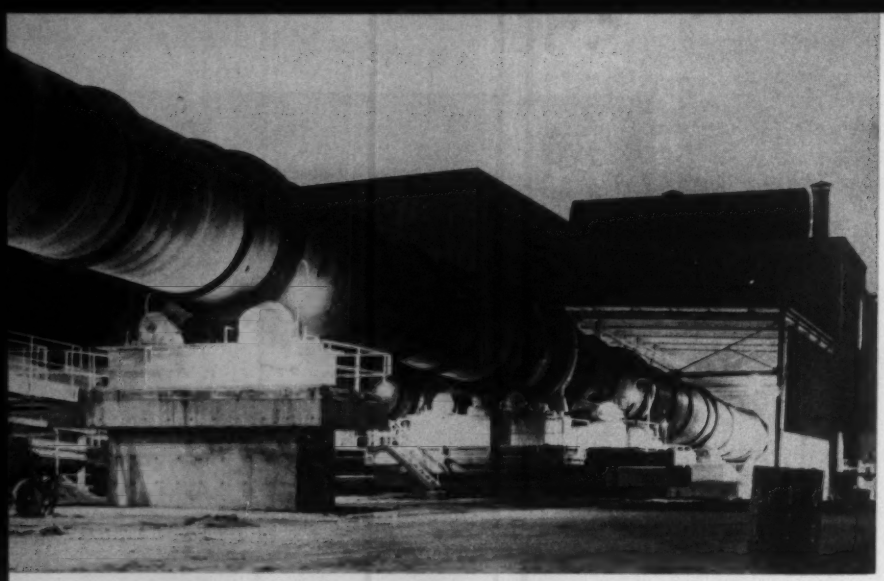
4 The covered storage area is approximately 80-feet wide by 680-feet long and is served by two 4-yard electric overhead cranes. Crushed cement stone is stored at one end of the area, and processed clinker ready for final grinding is stored at the other end. Between the two areas are storage bins into which the materials are loaded by the cranes for feeding to the grinding mills. Other storage bins at this section hold iron oxide, sand, alumina, and gypsum which are ingredients of portland cement.

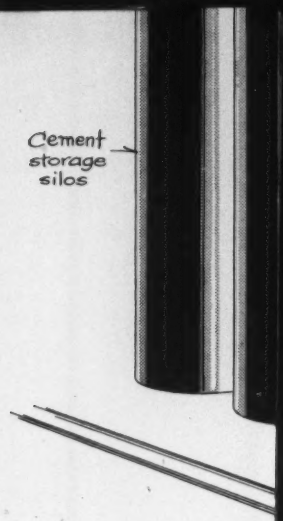


5 From the overhead storage bins crushed rock, iron oxide, sand, and alumina are proportioned in the proper amounts and fed onto this conveyor system leading to the ball or wet grinding mills. Automatic devices control the feeding of the ingredients so that all cement in a given production run will have the same characteristics. The proportion of raw materials is determined and closely controlled by laboratory personnel.



6 As the raw material mixture enters the ball mills, water is added. The mills are 9 feet in diameter, 37-feet long, and are operated by 1250-horsepower motors. Inside the mills are a great number of steel balls ranging in size from 1 inch to 4 inches in diameter. As the mills revolve, the balls roll and cascade with great force to pulverize the mixture into a slurry which consists of finely ground stone and about 35 per cent water by weight. The slurry is discharged from the mills through a vibrating screen which removes all materials larger than 40 mesh. Slurry passing through the screen is pumped to eight storage tanks where it is stored until needed at the rotary kilns. While in storage, the slurry is continually stirred to prevent settling of the stone particles.





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Slurry is next pumped from the storage tanks to two kiln feeders, one for each kiln, which measure the slurry by volume into each kiln. The two kilns are each over 11 feet in diameter, 400-feet long, and are driven at a speed of 1 rpm. They are inclined about ⅜ inch for each foot of length so that the slurry, fed into the upper end, will slide toward the lower end by the effects of rotation and gravity. As the slurry travels through the kilns, it is subjected to the heat of a burning coal-air mixture, 2800 F at the hottest point, which drives off the water and fuses and forms the raw materials into clinkers, varying in size from that of a pea to that of a walnut. The hot clinkers are discharged from the kilns into two clinker coolers for recovery of heat. When cooled to 150 F, the hard and brittle clinkers are moved to the covered storage area to await final grinding to a powder.

equipment per employee which is one of the highest figures in American industry. With many processes automated and remotely controlled, the plant is expected to set new standards in the industry for low operating and maintenance costs. Employee safety has not been overlooked since Alpha has installed safety features and guards of all types in the plant wherever there is any recognized possibility for an accident. The cement industry is the safest of the 40 major heavy industries in the United States according to the National Safety Council.

A major problem in the cement industry is the control of clouds of dust generated at almost every operation in the process—rock crushing, grinding, kiln burning, storage, packing, and shipping. Alpha has attacked this problem by investing $1 million in a dust control system which is designed to be the most efficient in the cement industry. Large dust particles are removed from the air by mechanical collection units, and small particles are collected by an electrostatic unit. For example, hot air from each of the two kilns is exhausted at a rate of 85,000 to 95,000 cfm. It is drawn through a mechanical dust collector which removes 60 to 70 per cent of the dust. The air is then drawn through an electrostatic dust collector which removes over 99 per

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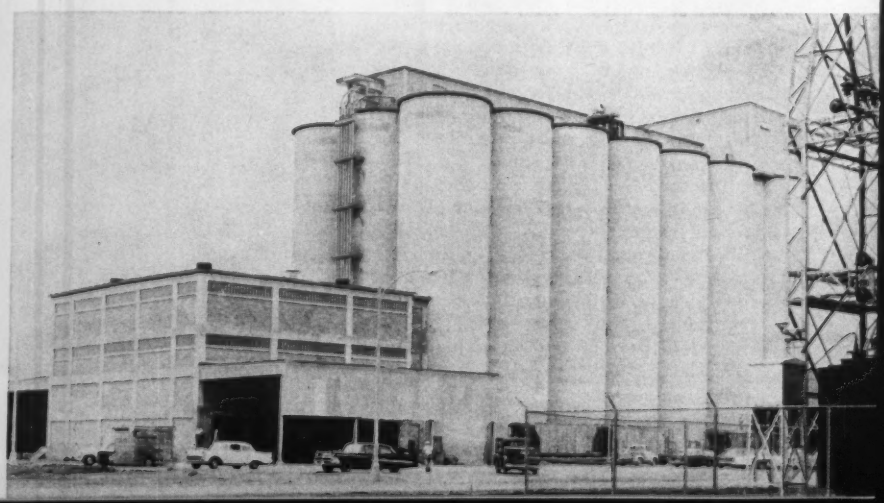
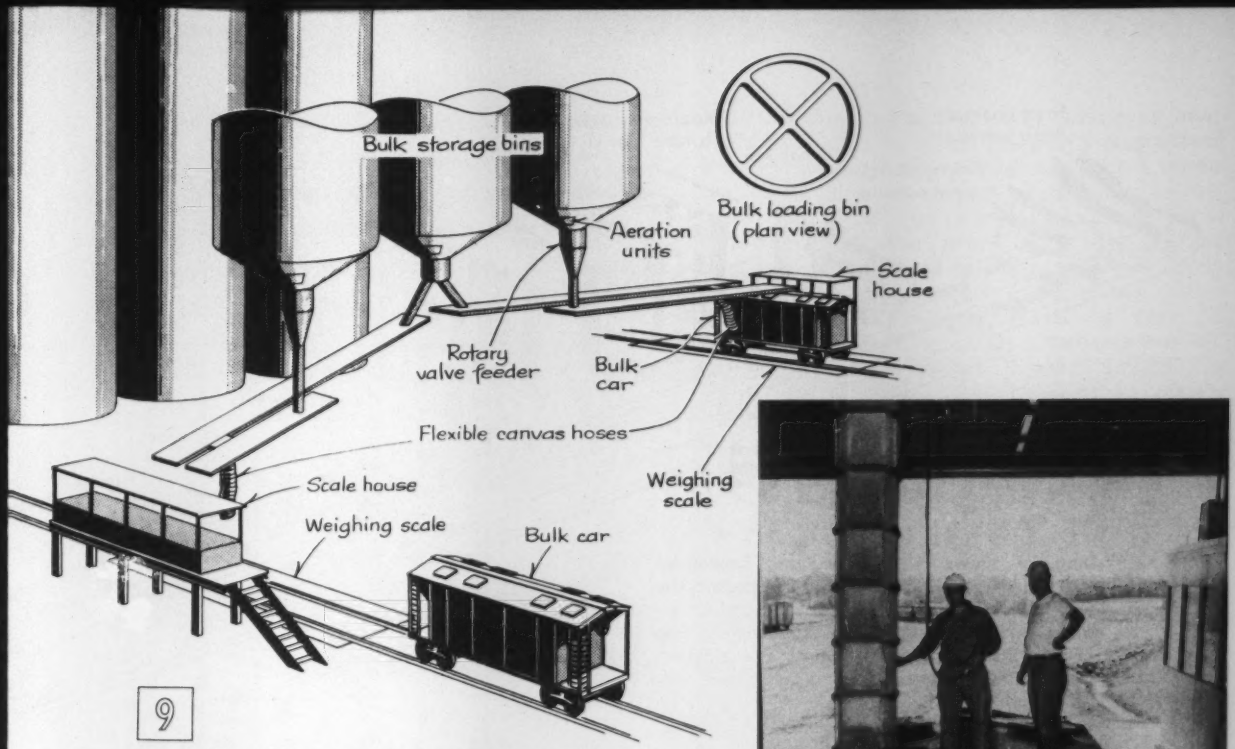
The clinkers are next finely ground with gypsum in ball mills until practically all the material will pass through a 200 mesh screen. High early strength and mortar cements are ground to pass through even finer screens. The finished cement is then moved in pipes by air pressure to eighteen 28-foot diameter by 110-foot high silos to await shipment. Total storage capacity of the silos is 300,000 barrels of cement.





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Most of the cement manufactured at Lime Kiln is shipped in bulk by freight cars. It is first transferred by air pressure through pipes from storage silos into three loading bins, each of which is divided into four compartments so that different types of cement can be stored in the same bin. When an order is received, cement is withdrawn from a storage bin, conveyed through ducts, and dumped into the top of a freight car through a flexible canvas hose. The freight car is on a weighing scale which provides a means for keeping account of the net weight of cement placed in each car.

cent of all dust that enters it. Elsewhere in the plant, other dust collection units effectively control dust at the rock crushing, grinding, storage, and packaging operations.

In addition to the Lime Kiln plant, Alpha has eight other cement plants which are located in the states of New York, Pennsylvania, West Virginia, Ohio, Illinois, Missouri, and Alabama. Total capacity for all the plants is 15,050,000 barrels of cement annually. Since 1945, Alpha has spent over $46 million on modernization of the older plants including $17 million for the new plant at Lime Kiln.

The accompanying illustrations highlight the many steps in transforming limestone rock into cement at the Lime Kiln plant.

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About 30 per cent of the cement is shipped in 94-pound bags. One operator handles four filling devices on each of the three automatic packing machines installed at the plant. As each bag fills to the top, the filling device shuts off automatically. After sealing, the bags are moved by powered conveyors either to warehouse storage or directly to freight cars for shipment.

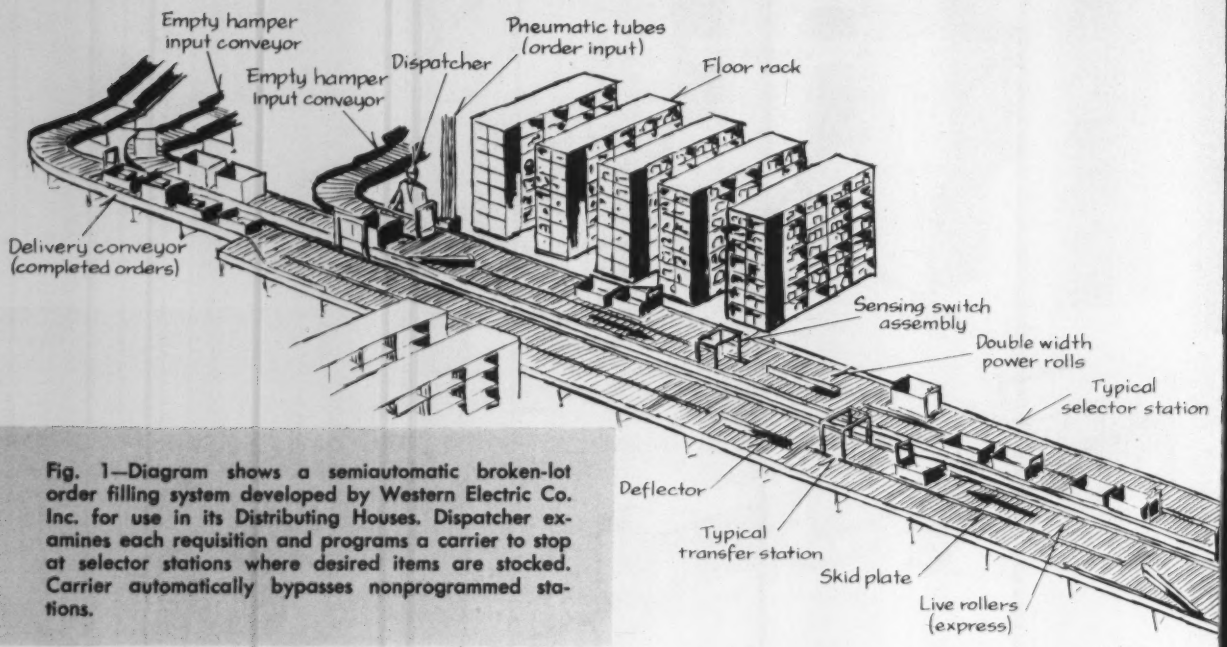


Fig. 1—Diagram shows a semiautomatic broken-lot order filling system developed by Western Electric Co. Inc. for use in its Distributing Houses. Dispatcher examines each requisition and programs a carrier to stop at selector stations where desired items are stocked. Carrier automatically bypasses nonprogrammed stations.

HANDLING BROKEN-LOT ORDERS ON A WAREHOUSING ASSEMBLY LINE

By **JOHN W. MULLER,**
Senior Engineer, Distribution Planning Engineering Org., Telephone Sales Div., Western Electric Co. Inc., New York, N. Y.

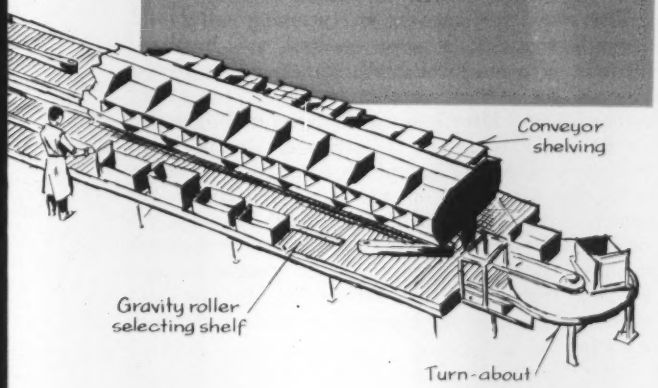
A WEEKLY CHORE of many housewives across the country is to make out a grocery list, drive to a supermarket, and select items for the dinner table from the many thousands of grocery, meat, and produce stocks carried by the store. Although each type of item is shipped to the store in multiple-unit lots, the housewife is usually interested in only one or two units of each lot. In like manner a daily necessity of many industrial warehousing organizations is to accomplish a similar task as the housewife's except the order selection from broken-lots must be done faster, more efficiently, and without the luxury of free time and labor.

This problem is of prime importance to the Western Electric Co. Inc. in the efficient operation of its system of telephone equipment Distributing Houses located in many parts of the country. Each warehouse handles as many as 8000 items which have been either manufactured in Western Electric plants or purchased in bulk from outside agencies. Some houses handle up to 1800 orders per 8-hour day with each order averaging approximately five items. Normally, about $2-3 million worth of business per month is processed through a house in routine equipment and supplies required for the operation of various telephone companies throughout the country. However, the distribution system must be able to cope with extreme conditions as might occur during the building or expansion of a central office, or in times of disaster such as floods, tornadoes, hurricanes, and the like.

Early Selection Systems

In the early days of Western Electric's Distributing Houses, a system similar to that used by the housewife in a supermarket was employed. A selector would secure a requisition and tour the ware-

Many manufacturing operations are concerned with efficiently packaging individual products into large lots for shipment. Of equal importance to a user of these products is an efficient method of breaking down the large lots into smaller quantities to fill broken-lot orders. A conveyorized system for accomplishing this task is described by the author.



house with a chart, picking up items as he went along. However, this system required a large number of selectors who wasted many hours each day in walking between item locations in the large warehouse.

To keep walking to a minimum and to increase output, another system was developed to bring an order container, by means of slow moving conveyor, to selectors stationed at merchandise racks. Each selector examined the requisition and added items to the container from his rack. A difficulty encountered in this system was that the selector had to be constantly on the alert to catch a requisition calling for an item at his location. If an order slipped by him due to inattention, it became necessary for the dispatcher to reroute the order, causing double handling and confusion since the requisition would appear as a new order to every selector along the line.

At this stage it was decided to develop an automatic order selection system based on a programmed conveyor loop. Design criteria called for a system that would allow one or more containers to be conveyed with each requisition, automatically divert each train of containers to any one or more selecting stations as predesignated by a dispatcher, and finally deliver the completed order to a packing station for shipment on a "same day as received" basis. A system that fulfills these design criteria has been installed in several Western Electric Distributing Houses. This system, *Fig.* 1, might be readily adapted to several types of warehousing operations such as a mail order house, or a manufacturer or distributor's small item or repair parts depot.

Programmed Carriers

The broken-lot order selection system consists fundamentally of a powered express conveyor loop which has a series of switching devices that divert one or more containers onto a parallel nonpowered roller conveyor at each selector station. When the operator has filled the requisition with items located at his station, he pushes the order containers back onto the express conveyor which carries the units to the next predesignated selector station. This process continues until the order containers have either entered or bypassed all the selector stations in the system, and the order is complete. A delivery conveyor then transports the entire order, which at this point may consist of one or more containers and several boxes or cartons, to a classifier who checks the content for completeness. The classifier also determines whether the order may be sent direct to a truck loading dock, or may require additional attention by a crew of packers.

Key man in the semiautomatic selection system is the warehouse dispatcher who is located at a central control station, *Fig.* 2, and has full control

Fig. 2—Order received from the field is processed and forwarded by pneumatic tube to this central control station for the order selection system. The dispatcher, at right, scans the requisition and raises pivotal pins on a container carrier so that the container will be automatically diverted from the inside express conveyor to an outside nonpowered conveyor at selected stations.

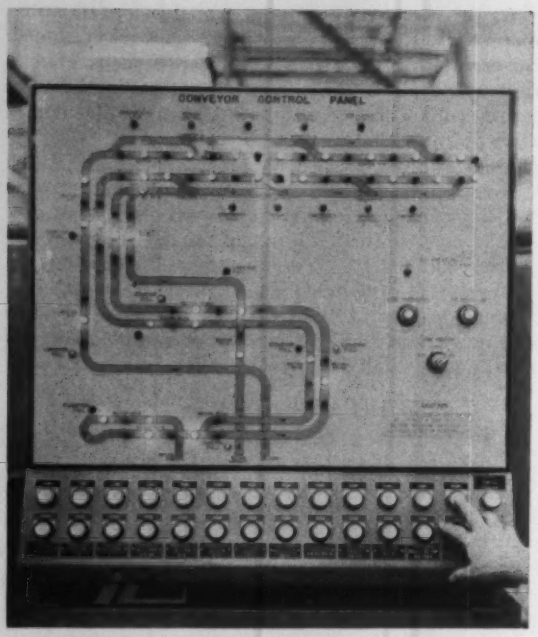


Fig. 3—Graphic control panel at the dispatcher's station monitors the entire system and warns dispatcher of delaying conveyor stoppages. Green, amber, and red indicator lights show condition of key points in the system at all times.

of all the conveyors involved in the selecting operation. The dispatcher has a thorough knowledge of the materials in storage and at what stations they are normally located. To aid the dispatcher in monitoring the system, a graphic control panel, *Fig.* 3, is located at the central control station and keeps him informed of the flow on all supply and delivery lines at a glance.

The dispatcher prepares to start an order into the selection system by programming the proper selector stations on a carrier—a flat steel platform with a vertical support at its forward end. Across the top of the vertical support is a horizontal row of pivotal pins in quantity to match the number of selector stations. By raising a pivotal pin to a vertical position, the carrier will be diverted from the express conveyor to a designated selecting position when the pin strikes a limit switch preceding the station. A stationary pin on one side of the vertical support is designated as an "express" pin and is used to reset diverting devices when a carrier is programmed to bypass a selector station.

The order containers used in the system are heavy-duty, open-type hampers having textile handles on each end. Merchandise is delivered to telephone companies in these hampers, and used materials and equipment are returned to the warehouse in the same containers for salvage or repair. The hampers are automatically loaded onto the carriers by a pneumatic cylinder actuated by a foot switch under the control of the dispatcher. When the foot switch is depressed, the pneumatic cylinder pushes a hamper from a hamper feed line onto a carrier on a parallel feed line directly in front of the dispatcher. Both the hamper feed line and the carrier feed line are kept supplied by other operations in another section of the warehouse.

The dispatcher surveys an incoming order and determines which selector stations are involved. He then proceeds to raise the corresponding pivotal pins on the vertical support of the carrier, places the requisition form into the hamper, and depresses a foot switch to release a stop gate. In the event that more than one hamper is required to hold the order, the dispatcher operates a pushbutton on the control panel and extra hampers feed out from the hamper line. These hampers follow the lead carrier as it is diverted to and from the various selector stations throughout the system. Only one lead carrier with programming pins is required for each separate order.

▶ Operation At Selector Station

As the lead carrier approaches a selector station stocking items on the requisition, the raised pivotal pin designating that station strikes a limit switch, *Fig.* 4, located on a bridge structure across the

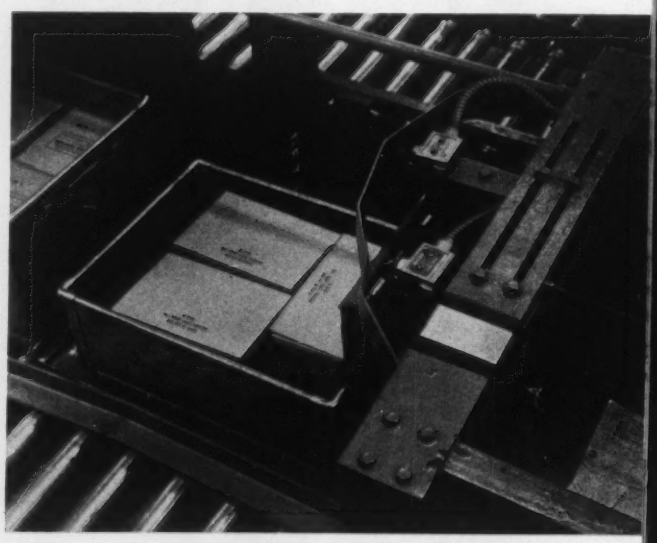


Fig. 4—Carrier approaching selector station can actuate these two limit switches located on a bridge structure over the express conveyor. If the pivotal pin and the stationary pin both contact their respective limit switches, electrical and pneumatic circuits automatically cause a deflecting plate to swing across the express conveyor and divert the carrier into a selector station. If only the stationary pin strikes its limit switch, the deflecting blade will either remain in a neutral position or be swung from an open to a neutral position so that the carrier can bypass the station.

express conveyor. A fraction of a second later the stationary pin on the carrier also strikes a second limit switch on the bridge structure. This action starts a sequence of pneumatic and electrical operations, *Fig.* 5, which raise a pneumatically operated gate to temporarily hold the carrier until a pneumatic cylinder can swing a steel deflecting blade across the express conveyor. The stop gate then lowers, and the carrier and following hampers are guided by the deflecting blade off the express conveyor, *Fig.* 6, and onto a nonpowered roller conveyor in front of the selector station operator. When the carrier has come to rest, the selector operator checks the requisition and fills the hamper or hampers with all items that are located at his station, *Fig.* 7. If a piece of equipment is in a box or carton that is too large to fit in a hamper, the operator merely places the unit in the train following the lead carrier.

During this time, the deflecting blade remains in its open position across the express conveyor. If the next order that follows is destined for the same selector station, its lead carrier programming pins will strike the limit switches on the bridge structure, but nothing will happen. Instead, the second order will be deflected onto the station conveyor, pushing the first order farther into the station. It makes no difference how many hampers, boxes, or parcels are included in the order, for all units will pass through the deflector position in the same manner as the lead carrier.

When a carrier destined for a different selector station approaches the limit switches on the bridge structure, only the stationary pin will strike a limit switch. This action starts a sequence for reversing the deflecting blade, *Fig.* 5, in which the stop gate raises to temporarily hold the order, the deflecting blade returns to its neutral position, and the stop gate lowers to allow the order to proceed on the express conveyor.

When the selector operator has completed his part of the requisition, the order is ready to be transferred back to the express conveyor for movement to the next designated selector station. This may be accomplished in two ways, depending upon the number of units making up the carrier train. For small orders of one or two units, the operator may push the carrier and extra hamper directly across a narrow skid plate onto the express conveyor, *Fig.* 8. For large orders of many units, the operator presses a manual control pushbutton located immediately in front of the next selector station bridge structure. This action causes the stop gate for this station to raise, stopping all traffic on the express conveyor. At the same time, the deflecting blade for the next station swings in reverse across the station conveyor forming a gate for conveyor access back to the express conveyor. The operator then pushes the order train toward the deflecting blade, *Fig.* 8, and powered rollers assist in moving the train onto the express conveyor.

When manual control is in effect, no automatic deflection can take place. Since this might cause a bottleneck if not used with discretion, a signal light on the dispatcher's control panel remains illuminated while the deflecting blade is in a reversed position. Therefore, if the light remains on for too long a time, the dispatcher can take action to investigate the bottleneck. As soon as the order train has cleared the selector station, the selector operator presses an automatic control pushbutton which causes the deflecting blade to return to a neutral position and lowers the stop gate, allowing orders to proceed normally on the express conveyor.

As a carrier leaves the last selector station for which it was programmed, it will travel along the express conveyor, automatically resetting deflecting blades to a neutral position by means of the stationary pin. The train then leaves the selecting system and is conveyed to checking and packing stations located in other parts of the warehouse.

The time to fill an order is subject to a number of variations such as the number of items, the number of selector stations involved, and the speed and dexterity of the selector operators. As a convenience, rows of small shelves are mounted over the express conveyor on which are stored all fast moving items. Slower moving items are stored in racks immediately to the rear of each selector station. Generally speaking, a normal order routed to three selector stations would pass through the system in about ½ hour of operating time. How-

THE AUTHOR

JOHN W. MULLER, senior engineer, Western Electric Co. Inc., is an engineering graduate of Pratt Institute and a registered professional engineer in the state of New York. Since his graduation in 1939, Mr. Muller served 3½ years in the U. S. Army Signal Corps during World War II, attaining the rank of Captain with service in the North African and European Theaters. His professional experience includes design and distribution engineering for electric utilities, sales engineering for a materials handling equipment manufacturer, and his present position of electric plant design and development for the Distribution Planning Engineering Organization of the Telephone Sales Div., Western Electric Co. Inc.

Mr. Muller is a member of the American Institute of Electrical Engineers, the New York State Society of Professional Engineers, and a fellow of the American Association for the Advancement of Science. This article is based on a paper prepared by Mr. Muller that was awarded fourth prize in the 1957-58 Clark Essay Contest sponsored by Clark Equipment Co. and the American Material Handling Society Inc.

PNEUMATIC AND ELECTRICAL CONTROL ACTIONS

HEART of the broken package order selection system is the automatic operation of the deflecting blades at the various selector stations. Each deflecting blade has three operating positions as shown in *Fig. 5b*. The neutral position allows order carriers to bypass a selector station; an open position diverts carrier trains from the express conveyor into the selector station; a reverse position permits the carrier trains to be pushed out of the selector station and onto the express conveyor. Steps in the operation of a typical deflecting blade through the three position modes can be followed by reference to the pneumatic and electrical circuit diagrams in *Fig. 5a, b,* and *c*.

Blade In Neutral Position. When the deflecting blade is in a neutral position, all pneumatic and electrical components are in the operating positions shown in the diagrams. Lead carriers bypassing this station have no effect on the circuits since only the stationary pin on the bridge structure will strike limit switch 1*LS*. Although this switch momentarily closes, no action occurs since limit switch 3*LS*1 is held open by virtue of the blade being in the neutral position.

Actuate Blade To Open Position. Lead carrier programmed for this station approaches bridge structure. Raised pivot pin strikes limit switch 2*LS*, opening contact 2*LS*1 and closing contact 2*LS*2. Stationary pin then strikes limit switch 1*LS*, momentarily closing this switch. As carrier continues to move, pins release switches in such a manner that 1*LS* is opened before 2*LS* is reversed to starting position.

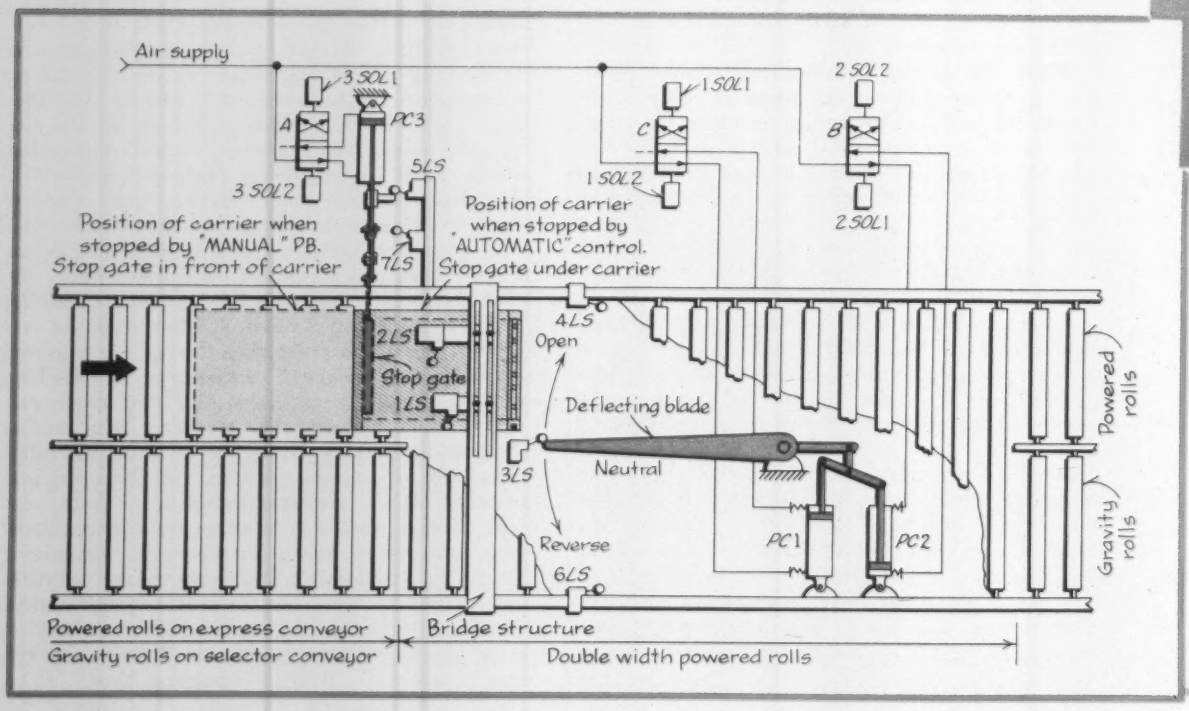
When contact 2*LS*2 is closed momentarily, latch relay 2*CRL* is energized closing contacts 2*CR*1, 2, and 3. Closed contact 2*CR*1 completes a circuit to solenoid 3*SOL*1 through closed limit switch 7*LS*, energizing this solenoid and causing the spool of valve *A* to shift, admitting air to the blind end of gate cylinder *PC*3. As the piston of this cylinder moves toward the rod end, a dog attached to the piston rod releases limit switch 5*LS*, allowing contact 5*LS*1 to close and contact 5*LS*2 to open. Latch relay 3*CRL* is energized through closed limit switch contact 5*LS*1. Contact 3*CR*1 closes, energizing time delay relay *TR*. During this time, the piston of cylinder *PC*3 has reached the rod end position, raising the gate and stopping the carrier on the express conveyor. At the same time, the dog on the piston rod strikes limit switch 7*LS*, causing its contact to open and de-energize solenoid 3*SOL*1.

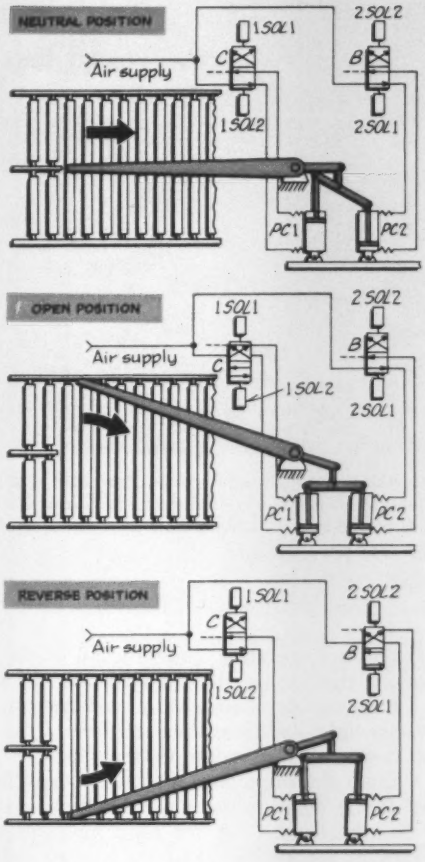
Through the operation of time delay relay *TR*, an order which may be in the process of passing through the selector station is allowed to clear. After the relay has timed out, its contact *TR*1 closes, and solenoid 1*SOL*1 is energized through previously closed relay contact 2*CR*3. This causes the spool of valve *C* to shift, admitting air to the rod end of cylinder *PC*1. As the piston of cylinder *PC*1 moves toward the blind end of the cylinder, a mechanical linkage attached between the piston rod and the deflecting blade causes the blade to swing open across the express conveyor. When the blade reaches its open position, it strikes limit switch 4*LS*, causing contact 4*LS*1 to open and contact 4*LS*2 to close. Through closed contacts 4*LS*2, 2*CR*2, and *TR*1, unlatch relay 4*CRU* and solenoids 2*SOL*1 and 3*SOL*2 are energized.

Energizing of unlatch relay 4*CRU* has no effect on the circuit since all contacts of this relay are already in the unlatched position. The same is true with solenoid 2*SOL*1 which causes no action since the spool of valve *B* is already in the shifted position. However, the energization of solenoid 3*SOL*2 causes the spool of valve *A* to shift back to its original position, admitting air to the rod end of cylinder *PC*3 and moving the piston of this cylinder back to its blind end. This action causes the gate to lower, allowing the carrier and train to enter the selector station by means of the deflected blade across the express conveyor.

As the rod of cylinder *PC*3 retracts, the dog on the rod releases limit switch 7*LS* and, upon reaching its home position, engages limit switch 5*LS*, opening contact 5*LS*1 and closing contact 5*LS*2. The contact of limit switch 7*LS* is mechanically arranged so that it closes after contact 5*LS*2 has closed to prevent re-energization of solenoid 3*SOL*1 through closed relay contact 2*CR*1. The opening of contact 5*LS*1 de-energizes latch relay 3*CRL*. The closing of contact 5*LS*2 energizes unlatch relays 1*CRU*, 2*CRU*, and 3*CRU*.

Relay 1*CRU* has no effect on the circuit since its contacts are already in the unlatched position. Contacts 2*CR*1, 2*CR*2,

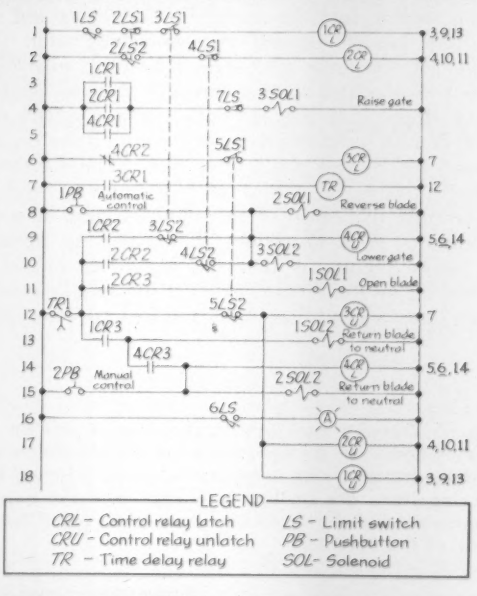




(b)

Fig. 5—Mechanical and pneumatic diagram (a) illustrates the operation of a deflecting blade at a typical selector station. Three positions of the deflecting blade and associated pneumatic circuits at each position are shown in (b). Electrical circuit diagram (c) identifies the various limit switches and control relays used in the automatic operation of the deflecting blade.

(c)



and 2*CR*3 are unlatched to an open position, de-energizing solenoids 3*SOL*1, 2*SOL*1, 3*SOL*2, and unlatch relay 4*CRU*. Contact 3*CR*1 is unlatched to an open position, de-energizing time delay relay *TR*, opening contact *TR*1, and de-energizing unlatch relays 1*CRU*, 2*CRU*, and 3*CRU*. The electrical circuit is now back to its original starting position with the exception of limit switch 4*LS* which is held in a reversed position by the deflecting blade and limit switch 3LS which is in a reverse position.

Actuate Blade To Neutral Position. Other orders programmed for this selector station will continue to enter this station as long as the deflecting blade is in the open position. However, when an order programmed for some other station approaches, the carrier will be held by the stop gate until the blade shifts to the neutral position. This occurs when the stationary pin strikes limit switch 1*LS*, closing its contact, while limit switch 2*LS* remains in its normal position. Latch relay 1*CRL* is energized, causing its contacts 1*CR*1, 2, and 3 to close. Contact 1*CR*1 causes solenoid 3*SOL*1 to be energized, allowing cylinder *PC*3 to raise the stop gate and hold the carrier as previously described.

When the piston rod of cylinder *PC*3 shifts, the dog on the rod releases limit switch 5*LS*, closing contact 5*LS*1 and opening contact 5*LS*2. Contact 5*LS*1 completes a circuit to latch relay 3*CRL*, causing its contact 3*CR*1 to close and energize time delay relay *TR*, which, in turn, times out and closes its contact *TR*1. Solenoid 1*SOL*2 is energized through closed contacts *TR*1 and 1*CR*3, shifting the spool of valve *C* and admitting air to the blind end of cylinder *PC*1. As the piston of cylinder *PC*1 moves to the rod end, a mechanical linkage attached to the rod and deflecting blade causes the blade to shift to the neutral position. At the same time, limit switch 4*LS* is released, causing its contact 4*LS*1 to close and contact 4*LS*2 to open. When the blade reaches the neutral position, limit switch 3*LS* is actuated, opening contact 3*LS*1 and closing contact 3*LS*2. Through closed contacts 3*LS*2, 1*CR*2, and *TR*1, solenoids 2*SOL*1, 3*SOL*2, and unlatch relay 4*CRU* are energized.

The circuit is now at a similar point as described in the actuation of the blade to an open position. Lowering of the stop gate, allowing the carrier to proceed to the next station, and unlatching of all relays occurs as previously described. When all actions have been completed, the electrical and pneumatic circuits are in their original starting positions.

Actuate Blade To Reverse Position. When a selector operator has finished filling an order, he can actuate a Manual Control pushbutton to move the deflector to a reverse position, allowing conveyor access to the express conveyor. Pressing the manual control pushbutton allows latch relay 4*CRL* to be energized, causing its contacts 4*CR*1 and 4*CR*3 to close and contact 4*CR*2 to open. The closing of contact 4*CR*1 causes solenoid 3*SOL*1 to be energized, allowing the stop gate to raise as in previous description. Solenoid 1*SOL*2 is energized through closed contact 4*CR*3 and manual pushbutton 2*PB*, but no action occurs since the spool of valve *C* is already in a shifted position.

At the same time that pushbutton 2*PB* is pressed, solenoid 2*SOL*2 is energized, causing the spool of valve *B* to shift. This admits air to the blind end of cylinder *PC*2, causing the piston to move to the rod end and to shift the deflecting blade to a reverse position through the mechanical linkage. In the reverse position, the blade strikes limit switch 6*LS*, illuminating a light on the dispatcher's control panel as a warning that the express conveyor is manually blocked.

When the selector operator has completed moving the carrier train onto the express conveyor, he presses the Automatic pushbutton 1*PB*. This energizes solenoids 2*SOL*1, 3*SOL*2, and unlatch relay 4*CRU*. Energization of solenoid 2*SOL*1 causes the spool of valve *B* to shift, admitting air to the rod end of cylinder *PC*2. As the piston of cylinder *PC*2 moves to the blind end, the deflecting blade returns to the neutral position. At the same time, energization of solenoid 3*SOL*2 causes the stop gate to lower as previously described, and energization of unlatch relay 4*CRU* allows its contacts 4*CR*1, 2, and 3 to return to their normal position. The system is now in its original starting position with the deflecting blade in the neutral position.

ever, the nature of the operation is such that a back-log is generally created at the checking and packing stations at the end of the day, and this factor may add another ½ hour or more to transit time of orders through the system.

Design Features

All supply conveyors feeding into and out of the order selection system are mounted at ceiling height to conserve operating floor space. On long conveyor runs where several tandem power driven belts are used, photoelectric cells provide automatic full-line protection of the individual drives operated from the central control panel. Safety switches and jog buttons for these elevated drives are mounted on columns within sight of the photoelectric devices. If a hang-up is signaled by the photoelectric cell to the central control panel, the dispatcher can direct a selector operator over an intercom system to restart the halted drive via the jog button. If the operator cannot clear the stoppage, he can throw the safety switch, disconnecting power to the drive motor, before calling maintenance personnel.

For simplicity in reading the graphic control panel at the dispatcher's station, *Fig.* 3, a three-color coded system is used for denoting conveyor operation. Within the conveyor path representation on the control panel are mounted a series of green, amber, and red indicator lights. When all conveyors in the system are operating normally, all of the green indicator lights are lit. If a photoelectric cell signals that a hang-up has occurred in a feed line conveyor, an amber light will illuminate in place of the green light at the affected point in the diagram. This will caution the dispatcher that action may be necessary if the delay is not cleared within a reasonable length of time. A red light indicates that a conveyor in the system has been stopped either by a selector operator or by a safety device and must be restarted from the control panel.

Located along the entire length of the selecting conveyor are a series of emergency stop, maintained-contact type pushbutton stations. These are positioned so that any selector operator will be working within twenty feet of one of these stations at all times. Depressing any emergency stop pushbutton will halt the express conveyor at the respective control station, along with its corresponding deflecting unit, and all conveyors and deflecting units feeding into this position. Conveyors and deflectors located beyond the emergency stop station will continue to operate, keeping man-hour loss to a minimum. Simultaneous with the emergency stopping of any conveyor, an alarm bell will ring and an indicating lamp will light on the control panel, pinpointing the trouble spot. The dispatcher may quickly, by means of the intercom system, determine the cause of the stoppage and take the necessary steps to restore the system to normal. A safety feature is that the conveyor cannot be restarted by the dispatcher until the specific emergency stop station has been restored to reset posi-

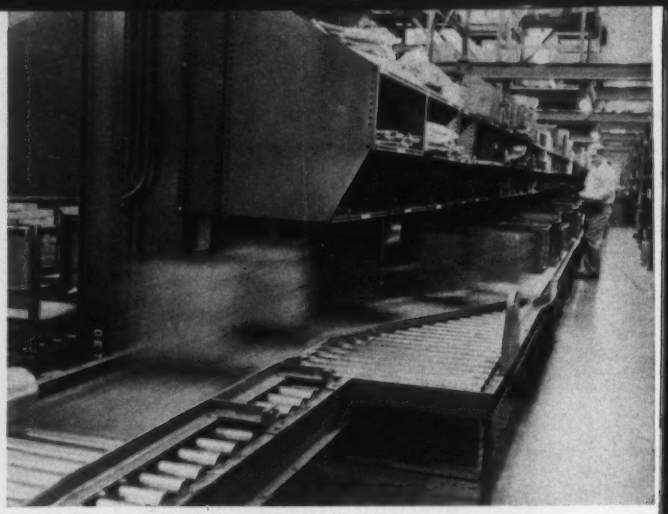


Fig. 6—Action view shows a carrier train being diverted off the express track and onto the conveyor at a selector station. Speed of the express conveyor is adjustable up to 120 feet per minute.

Fig. 7—When a carrier train comes to a halt on the station conveyor, the operator scans the requisition and fills the hampers with items stocked at his position. Fast moving items are stocked in a rack over the express conveyor, and the remaining items are racked to the rear of the operator.

Fig. 8—The carrier can be returned to the express conveyor in two ways. Small trains of one or two units can be pushed over a narrow skid plate separating the express conveyor from the nonpowered unit. When many hampers are in the train, the operator can actuate a pushbutton to move the deflecting blade to a reverse position. Double-width powered rollers then help the operator move the train onto the express conveyor.

tion. Therefore, two or more people are responsible for restarting the system after a stoppage has been cleared.

A system under the direct control of so many people is often conducive to frequent stoppages for reasons such as load variations, varying demand peaks at particular selector stations, and during the breaking in of new employees. Consequently, it was necessary to design the deflector control system with a reasonably foolproof circuit so that upon restoration of power after an emergency stop, all orders that were in the actual process of switching would resume their proper flow. Confusion caused by split orders, resulting in increased operating costs, was thus mimimized.

Five broken-lot selecting systems have been designed and installed in Distributing Houses of the Western Electric Co. Inc. Modification and improvements are continually being made on each successive installation to bring about further reductions in labor, to effect economies in installation and operation, and to reduce order handling time.

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EVOLVING AN ASSEMBLY MACHINE

FOR TUMBLER LOCKS

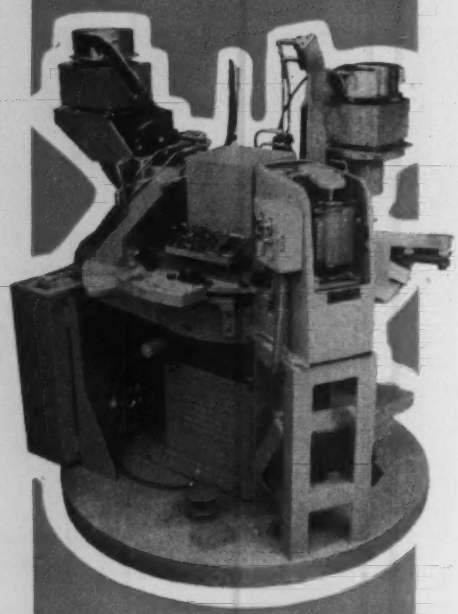


Fig. 1—Machine combines automatic and manual operations to assemble tumbler lock elements. Approximately 100 parts are placed per minute to produce about 8 assemblies. A unique indexing arrangement carries assembly fixtures past the operator twice for each cycle.

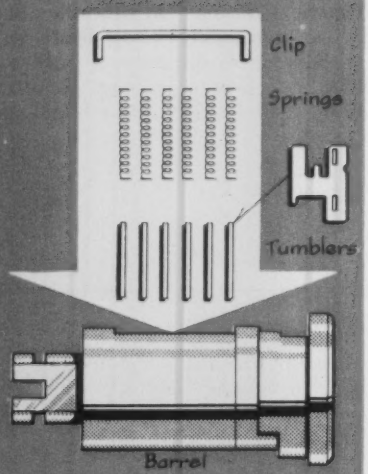


Fig. 2—Parts assembled in the lock machine are the lock barrel, six sheet metal tumblers, six springs, and a retaining clip. Over-all the barrel is only 1⅜ inches long by ¾ inch OD. The tumblers are identical when assembled; coding for different keys is performed in succeeding operations.

After all the necessary people are convinced that an assembly machine will solve a production problem, its design and fabrication can proceed. But all the details affecting operation cannot be foreseen. Preparing the machine to pass the acid test of daily production operation therefore requires experience, patience, and ingenuity all the way to successful production status. The author describes some of the considerations involved in building and putting a lock assembly machine into production operation.

By ROBERT MOORE
President
Moore Equipment Co.
Indianapolis, Ind.

LOCKS are ubiquitous items in our society. They are found in a range of shapes and sizes to fit their multitudinous applications, and individual designs may be used in quantities of hundreds, thousands, or millions. Tumbler locks for automobile doors are used by the millions, and each one includes small hard-to-handle components such as springs and tumblers. One manufacturer faced with making these locks brought in Moore Equipment Co. to design and build a machine to assemble them. The machine which resulted is the one in *Fig.* 1. A partial history of that machine helps to illustrate some of the considerations important in the successful bringing of such a machine to a production status.

The operations performed assemble six tumblers, six springs, the barrel, and a retaining clip, to produce about eight assemblies per minute, *Fig.* 2.

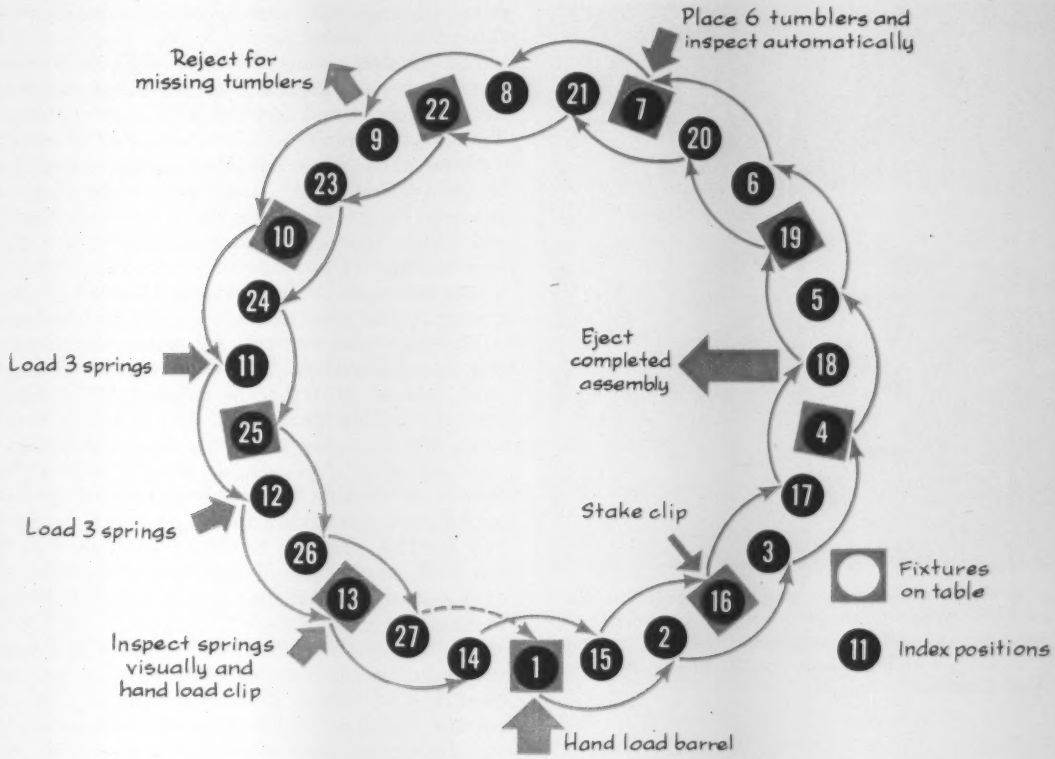


Fig. 3—Assembly cycle of lock machine provides two revolutions of index table. Operator hand places the barrel; tumblers and springs are automatically placed; same operator inspects spring placement and places retaining clips; and assembly is staked by hydraulic press and ejected from fixture. Two operators would have been required to perform same operations on one revolution of indexing table.

Build-up of the assemblies is accomplished in nine fixtures on a rotary indexing table, *Fig.* 3. Vibratory bowls are used to automatically feed the tumblers and springs to placing mechanisms. The barrel and clip are manually placed by the operator, who makes a visual inspection of the spring placement before the assembly is staked by a hydraulic press. It was decided to feed the barrels by hand since there are several variations used. When the six tumblers are placed, they are checked so that if any tumbler is missing the assembly will be rejected at a succeeding station. Inspection for proper placement of the six springs and placing of a clip were decided to be manual operations. Ejection of the completed assembly is automatic, *Fig.* 4.

An unusual indexing arrangement is used on this machine to allow the barrel to be placed by the operator; then, after several automatic placing operations, to come past the same operator for inspection of springs and hand placing of clip. Twenty-seven indexes spread over two revolutions of the table dial (26 degrees 40 minutes of arc per index) are required to return a given fixture to its starting position. By using a two-revolution cycle for the dial, only one operator is required instead of the two operators that would have been required for a one-revolution cycle. Since its index positions for the second revolution are different from its positions for the first revolution, a fixture does not stop under the same placing heads on both revolutions. Therefore, complex timing and alternate tools at a single position are not required to perform alternate operations or prevent a wrong operation. This indexing idea was one that came from the user. With respect to user contributions, it is interesting to note that the attempt was made to select the best components for this machine, and the user assisted in this effort. In fact, the user made information available on past experience with numerous components in an excellent list of preferred manufacturers of components.

▶ Providing For Nonuniformity

The main problem in automatic assembly is to obtain uniform parts. Inspectors may state that all parts in a given lot are within print. This is sometimes true of the important dimensions necessary to make the assembly function. It is almost never true of unimportant dimensions; especially since many of the functionally unimportant dimensions

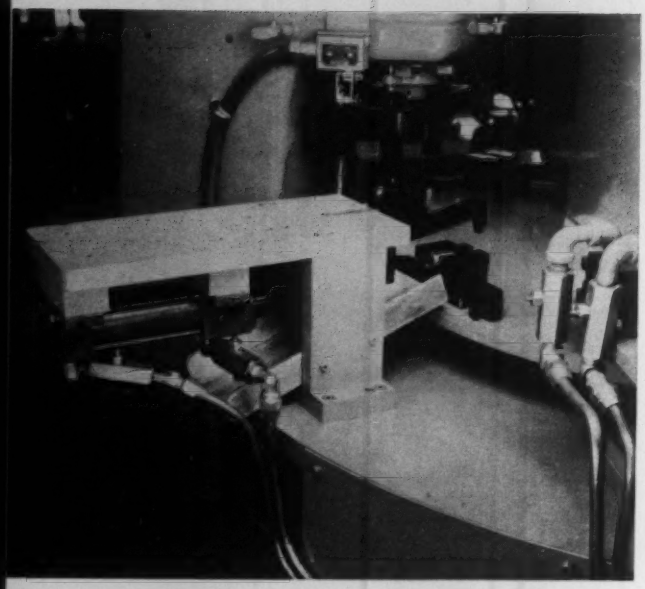


Fig. 4—Automatic ejection station removes assembly from fixture after hydraulic press stakes retaining clip in position. A similar arrangement, following the tumbler placing and inspection station, rejects units with missing tumblers.

are not specified on the print. Flash on plastic parts and burrs on stampings get progressively worse during a production run. Radii change with different shipments of metal. Slight variations occur in multiple cavity molds. Some 10-32 nuts get in with 10-24 nuts. Dirt, cigarette butts, and entirely different parts somehow get mixed into part supplies.

None of these variances present a serious problem with hand assembly. The assembler also acts as an inspector with little loss of time. With machine assembly it is sometimes necessary to insert a parts inspection operation before assembly, as well as the customary inspection after each operation. This lock assembly machine was no exception. An uninterrupted run of two minutes was unusual until the tumblers were inspected before assembly.

It was known when the machine was designed that non-uniform parts supply would be a problem, so several precautions were taken. Dirt chutes were included in the vibratory feeders and tracks. Easily cleaned contour blocks were inserted just beyond the feeders so that any malformed parts would stick there and be easily removed. Placing heads were made easy to service and remove bad parts. Finally, units are inspected after placement operations to detect faulty assemblies.

The tumblers were the most difficult parts to handle. It was necessary to provide a means to feed the correct end forward with a given side up. This was accomplished with a section of narrow track on which misoriented parts would not balance. It was imperative to use a very low amplitude of vibration for the selection point to function properly, and 90 per cent of the parts coming up the track were misoriented and had to be rejected. Therefore, it was necessary to have a large number of parts coming up the track to attain the required feed rate.

The high rate required was not obtained solely with conventional tracks around the inside of the bowl because of the pitch required for a double track (a double track bowl, like a double thread screw, has twice the pitch of a single track on the same size bowl). In order to get the required feed rate, a tube with single spiral track around its outside was constructed in the center of the bowl, *Fig.* 5. This auxiliary track delivered parts to the top track on the rim of the bowl. Overflow from the top track fell onto the second track. For tumbler feeding, a contour block and escapement are located at the end of the feeder bowl track. The contour cutout in the escapement is machined to stop any oversize or deformed parts. Openings beyond this contour block are all larger, and stoppages due to out-of-tolerance parts occur in the removable slide block of the escapement.

Up to this point the tracks are full of parts. Beyond this point there is only one part in the track at any one time. This eliminates the possibility of two parts wedging together and jamming the track. It also makes possible a much larger track and re-

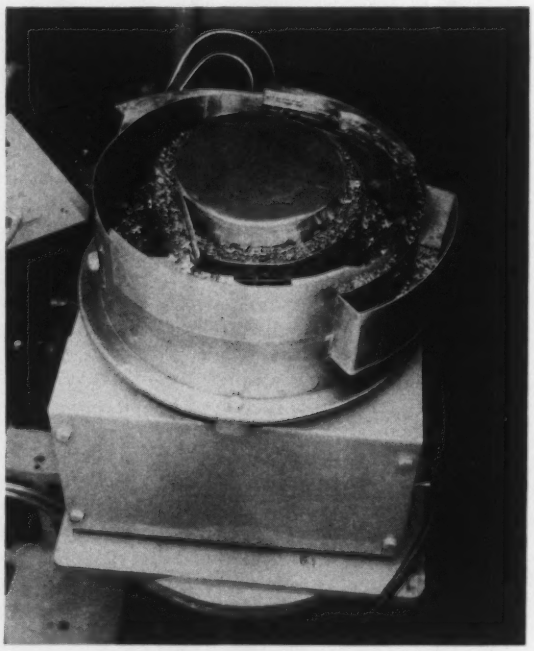


Fig. 5—To meet the demand rate, this vibratory bowl unit was developed to feed and orient tumblers for the automatic placing head. The track around the central tube supplies parts to the two tracks around the rim of the bowl. Production changes replaced this double-track unit with two single-track units.

duces the chance of sticking. This is a good standard procedure for many parts, and is particularly good where a bend in the track is necessary. When dealing with small, light parts, gravity can not be depended upon to move them since a speck of dirt, a drop of water, or a film of oil can stop them in the track. With this in mind, this machine was designed with air blasts to help parts along the tracks.

All tracks were made of rectangular cross section and assembled from separate pieces rather than being end milled from solid stock. This design made it possible to harden and polish all faces, and to provide a removable cover on one side of the track. By loosening two thumb screws, a complete track system can be exposed.

A mechanical switch was used to distribute the tumblers from the two feed tracks to the six tracks of the placing head. Then at the placing head a transfer slide moves out from under the delivery tracks to deposit the tumblers in the placing head at the proper time. When the placing head is in position over a lock barrel, six plungers move over the head and push the tumblers past a detent bar into the lock barrel. These plungers, mounted on 0.095-inch centers, are only 0.075 inch in diameter. They are straight lengths of music wire and are readily replaced if damaged. If any tumblers are missing, the associated plungers over-travel and operate a switch bar. This switch bar operates a memory circuit which rejects the faulty assembly at the next station.

▶ Handling Springs

The most difficulty was anticipated in handling the springs. They often squeeze together, and if the ends are open they tangle. The development of a 120-cycle vibratory bowl made feeding of these springs practical. The 120-cycle unit gives faster feed rates without the vertical bounce encountered on old style 60-cycle units. A double-track feeder was used for the springs. Gravity and the pressure from the feeder combine to move the springs along polished tracks. A clear plastic cover was used on the tracks so the springs could be observed at all times.

In the escapement for the springs, a pointed escapement pin extends into the track to hold the second spring in the track. A square pin under the leading spring completes the simple escapement. This escapement is covered with a hardened and ground plate. Springs are also distributed by a mechanical switching arrangement from two feeder tracks to six tracks for the placing heads.

Where it was necessary to use tubes to deliver the springs to the placing heads, stainless steel tubes were used. Tubes are undesirable because they cannot be cleaned easily, and parts cannot be observed inside them. Plastic tubing is sometimes used, but it is soft and wears. To facilitate cleaning of the tube sections of the feed paths, tubes were attached to hardened and ground end blocks. Each tube assembly can then be removed with thumb screws.

Because of the close spacing involved, two placing heads are provided for springs. Springs 1, 3, and 5 are placed by one head, and springs 2, 4, and 6 by the other. At the designated time in the machine cycle, a placing head containing three springs comes down to rest on the lock barrel in a fixture. To eliminate possibilities of the springs coming back up with the head, plungers hold the springs down in place as the head comes up. Then the plungers come up and the spring placement is complete. Parts of the heads coming into contact with the springs, or having possibilities of jamming, can be disassembled with thumb screws, *Fig.* 6.

Oddly enough, this function which had been expected to be the most difficult proved to be the most trouble-free. This was due to the excellent quality and uniformity of the springs.

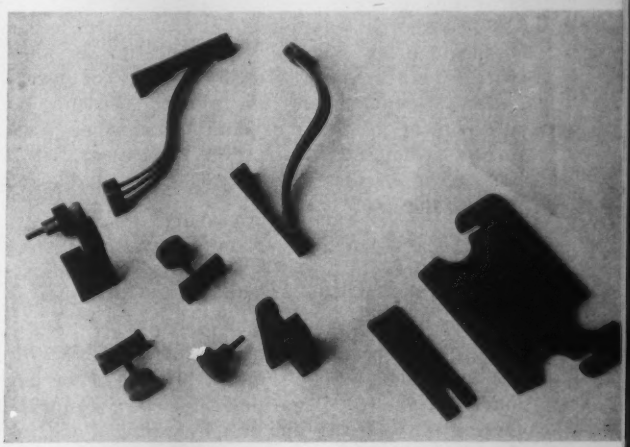


Fig. 6—Covers and sections of the feed tracks handling tumblers and springs were made readily removable. Tracks were designed as assemblies so faces contacting parts being handled could be hardened and ground. Where tubes were used to convey springs, they were fitted with end blocks so that the complete tube assembly could be quickly removed for cleaning.

▶ Adjusting Feed To Demand

A vibratory feeder for a complicated part performs only over a narrow range of speeds. The more complicated the part, the more delicate the orienting must be, and the required speed or amplitude becomes more critical. A requirement of a high feed rate further reduces the allowable speed range. Although a principle of operation is proved in the first track of a multiple-track feeder and only needs to be copied in the second, the first track for a difficult part is the easy one. After two tracks have been made to operate separately, the

speeds at which the two will operate never seem to be the same. Then begins the tedious process of making both tracks operate satisfactorily at the same speed.

For hard-to-feed parts, the difficulty of such adjustment goes up as the square of the number of tracks. For this reason, wherever the delivery rates will allow, switching devices can be effectively used to distribute the flow of parts from one or two tracks to several tracks. In the lock assembly machine, such mechanical switches, *Fig.* 7 and 8, are used for both the tumblers and springs. Each of these switches contains two slides which are independently positioned by air cylinders. In this machine, the slides are at rest when parts are passing through them; no attempt was made to use the switches as escapements. With larger, solid parts, such a switch can frequently be used as an escapement also.

When the delivery rate from one or two feeders is adequate for demand on several tracks, these switches are frequently used in place of several feeders. When the feed rate from one feeder is not sufficient to meet the demands of a single track, such a switch can be used in reverse manner to bring parts together from several feeders and switch them to one track.

In-Construction Changes

Since it is possible to profit from the difficulties encountered by others, a review of some of the bugs found in the lock machine may be worthwhile. During the building and initial testing of the machine, some modifications were incorporated. In the initial design, a cam timer was used with mercury switches. These switches would carry a heavy current and could be expected to last a long time on this type of operation. But it was found that stopping the timer in a certain position could produce a double impulse due to a surge of mercury in the tube. This problem was corrected by replacing the mercury switches with mechanical switches.

The index table used in the machine was purchased with the table accurately jig bored for nine fixtures. Unfortunately, although the positions on the table were accurate, the index mechanism was not. The solution used was to re-bore the table to correspond to the indexes. This was accomplished by mounting a boring head on the machine, indexing the table, and boring it in place.

It was also found that an operator could not keep up with the planned rate of 10 assembled units per minute. The speed of operation was therefore reduced to 8.4 units per minute.

The index table was equipped with a barrel cam, having 270-degree dwell and 90-degree index, and an electric clutch and brake system. Originally the clutch and brake were operated on each cycle to give a longer dwell. Then ways were found to reduce the dwell required. Instead of stopping the barrel cam each index, it was possible to use just the dwell on the cam and eliminate all the extra movements of parts in the clutch, brake, and timer.

When the machine was completed, the user sent an engineer to the Moore plant for a few days. A test run was made with a Moore operator under the supervision of the user's engineer. The performance was satisfactory, so the machine was accepted, delivery made, and the machine paid for.

Theoretically the builder's responsibility ended there. However, under actual shop operating conditions—operators not thoroughly familiar with the machine, run-of-mill part supplies—performance was not as desired. A man from the Moore shop

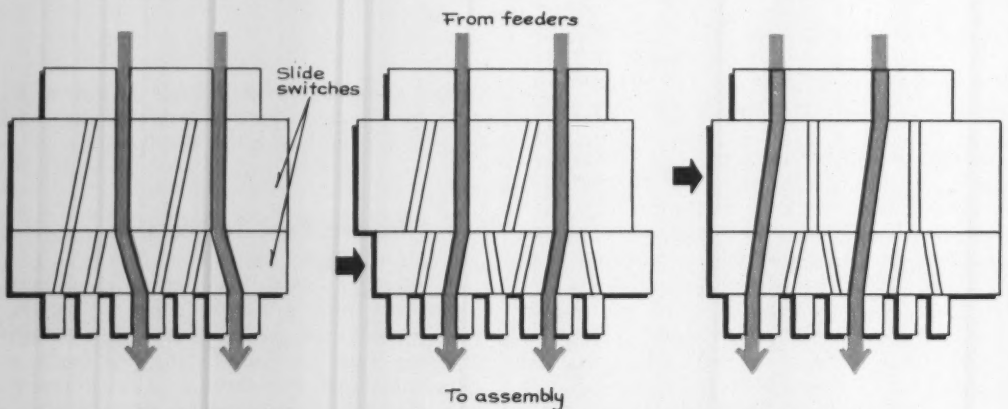


Fig. 7—Air cylinders operate two slides in a switching mechanism that distributes parts from two feed tracks to six tracks for placing in the assembly. Two such switches were used in the lock machine—one for tumblers, the other for springs. By appropriate design of tracks, such switches can also be used to supply high demand on a single track by combining parts flowing from several tracks.

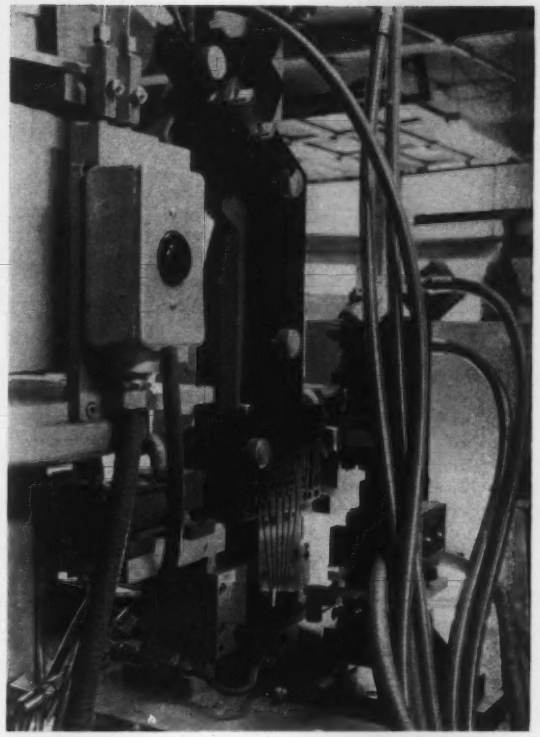


Fig. 8—Part switching mechanism for tumblers is shown on lock machine. Because of the nature of the parts, the escapement function is not performed by the switch, but by a separate escapement in the two supply tracks.

went and improved the operation but did not obtain good performance. Due to the press of other work, several successive engineers from the user's plant worked with the machine without achieving desired performance.

Since the machine had been operated successfully in the Moore plant, it was felt that the machine could be put back into operation there. It was arranged to return the machine and put it back in operation at Moore expense—with two stipulations. First, a production man, who would be in charge of the machine in the user's plant, would be sent to run the machine by himself for not less than two weeks. Second, since non-uniform tumblers were felt to be causing much of the trouble, they were to be inspected to obtain no more than one bad tumbler per thousand tumblers. Since six tumblers and six springs are automatically handled for each assembly, at a rate of over eight assemblies per minute, about 100 parts are handled per minute. If one part in a thousand caused trouble, the machine would be stopped every ten minutes to correct it. The user readily agreed to these stipulations.

Eliminating Production Bugs

After the machine was returned, several minor changes were made to increase the reliability of operation and make servicing easier. The double-track feeder bowl for tumblers was felt to be too critical for this production operation, so it was replaced with two single-track 120-cycle units. The discharge angle for tumblers was changed from 30 degrees to 45 degrees to eliminate sticking in the track. The bottom of the tumbler track was hinged at the gage point for easier removal of defective parts. In addition, a spring-loaded slide was provided for the escapement. The escapement moves one tumbler horizontally from a stack and drops it down the track with an air blast. Occasionally a tumbler would stick and be damaged by motion of the slide. Spring-loading of the slide corrected this.

The discharge chute of the spring feeder was detached from the vibratory bowl and attached to the stationary track. This is frequently done now to increase the feed rate or to make a feeder less critical. The reason for this change is that the force in a vibratory bowl tends to move the part in a circle around the center of the bowl, while the discharge chute comes off the bowl at a tangent, *Fig.* 9. The longer the discharge chute, the less the force tends to move the part out of the chute, and the more the force moves the part laterally in the chute, 90 degrees to the direction of travel. If the chute is extended far enough, the parts will no longer move. If the track on the bowl ends at the point of tangency and the stationary

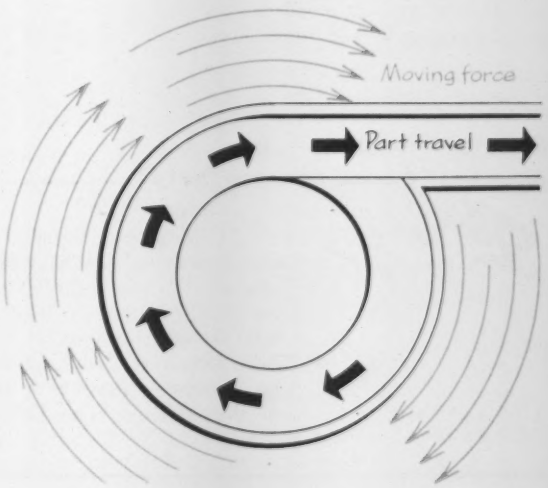


Fig. 9—Schematic plan view, of a vibratory bowl feeder and the forces that act on parts, illustrates why the chute vibrating with the bowl should not be too long. Forces developed by the feeder motion tend to move parts in circular paths and push parts against the side of a tangential discharge chute.

track begins there, the vibrations do not slow the parts in this stationary track. To help move the parts in that track, air jets were added and the downward slope of the track increased.

The clear plastic plate that covered the spring tracks was replaced with a cover that extends only partially over the springs. About 75 per cent of each spring is exposed. When a defective part appears in a track it is no longer necessary to remove the cover and dump all the springs in both tracks. By inserting a small hook in the defective spring the operator can snap it out past the partial cover.

Originally the cam timer was driven by a small electric motor. The index table was driven by a separate motor and stopped and started with a brake and clutch. The cam timer controlled the brake and clutch as well as air valves. Under certain conditions of turning air and electricity on and off, it was possible to get the timer and table out of phase. It was similar to getting the camshaft in an automobile engine out of time. The results were horrible, and it was difficult to re-time the equipment. The timer motor was removed and the timer provided with a chain drive from the index table.

A second test run was made in the Moore plant by the user's operator. After the operation was explained and necessary service demonstrated, the operator was on his own. This was to simulate the conditions he would encounter in his own plant after re-delivery. Within two weeks he was sure he could handle the operation and service in his plant, and the machine was shipped. It is now in production operating at 80 per cent efficiency. Inspection of tumblers shows 10 per cent are defective in some way. When a tumbler inspection machine is put into operation, the efficiency of the assembly machine should increase materially.

Looking back after completion of the machine, Robert Jennings, who was in charge of design and debugging, feels it was successfully completed only because of the ease of disassembly. If it had taken ten minutes to clear a jam instead of less than one, the debugging would never have been completed.

THE AUTHOR

ROBERT MOORE is owner and president of Moore Equipment Co. He started in his own business in 1939 after experience in machine and tool design in several plants.

Originally activity was in the photographic equipment business; World War II made it necessary to go into parts manufacture. Tool work and production parts manufacture were performed for automotive and aircraft uses.

After the war, emphasis switched to special machinery—"Which was always my first love," admits Mr. Moore. In the course of building such machines, a vibratory feeder was developed. Production of these feeders is now part of the business. Special machines now built include some type of feeding or small parts handling equipment.

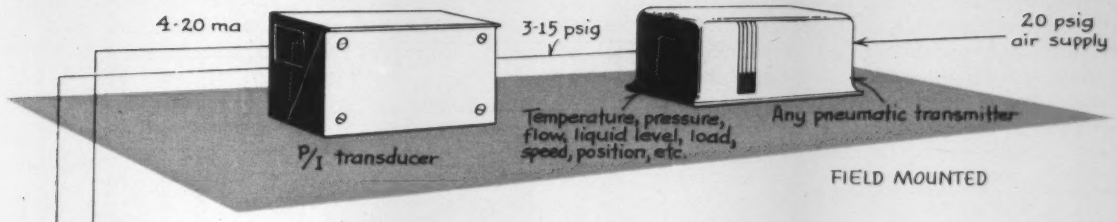
Lock Coding

Since locks must be unlocked only by the proper key, tumblers must be coded to fit a given key. In locks assembled on this machine, the tumblers are all the same when placed in the barrel. A later operation on another machine removes selected portions of the tumblers to provide the coding.

In the alternate major procedure for lock production, different tumbler designs are inserted in the lock barrel to provide coding. Some locks made in this manner have tumblers with "windows" of different shapes to provide the variations. If a lock had six tumblers and there were six different window variations, there would be a possibility of six to the sixth power (or 46,656) variations of this lock. In practice, not all these possibilities would be used, but the machine to perform the assembly job will be quite complex. Work has already been performed on plans for such an assembly job. It may have a keyboard or an automatic sequencing device to select the desired tumblers.

can we help?

It has been pointedly mentioned at various times that in engineering automated systems new as well as old techniques and devices may prove extremely useful. Practical results require the investigation of all available equipment that can contribute to the effective development of suitable automatic lines. Information on such equipment is presented in various departments of the magazine each month as useful data become available. To aid in obtaining detailed data for further evaluation a post card is included on Page 19. Take advantage of this service. The Editors will be glad to help in this or any other way.



EXTENDING PROCESS CONTROL

WITH PNEUMATIC-ELECTRICAL TRANSDUCERS

Where technological change occurs, the new does not always supplant the old. An excellent example is found in examining the role of electrical equipment in process instrumentation. The author shows how electrical techniques (the new) complement pneumatic techniques (the old) to provide greater flexibility for specialized jobs.

By **WALTER S. SHARSHON,** Application Engineer, Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

FOR a number of years pneumatic systems using the transmitter-receiver concept have been predominant in many process applications. There is every reason to expect that there will be a continuing need for these systems. Behind pneumatic systems is a long period of development and extensive field experience. The broad range of available pneumatic instruments is reliable and versatile, and it is easily understood and maintained by operating and maintenance personnel.

Systems based on electrical techniques, on the other hand, have progressed at a slower pace. Except for certain measurements—such as conductivity, pH value, gas analysis, and the like—there were no compelling reasons for

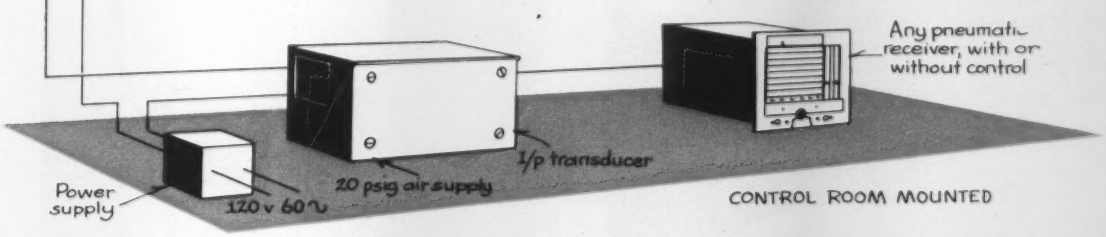
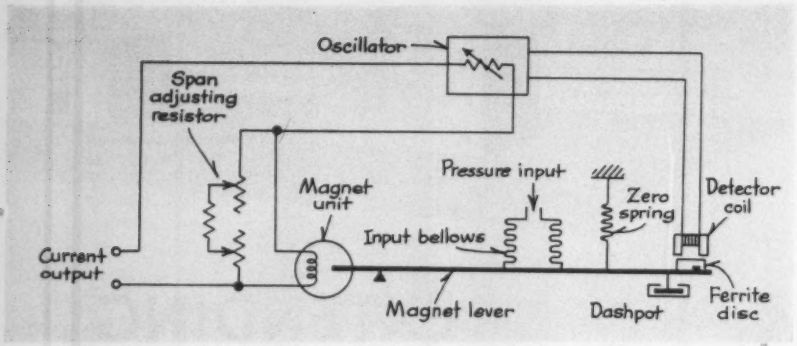


Fig. 1—Placement of pressure-to-current transducer (P/I) and current-to-pressure transducer (I/P) in control loop is illustrated. A similar arrangement would be used between a pneumatic controller and a pneumatically actuated control valve.



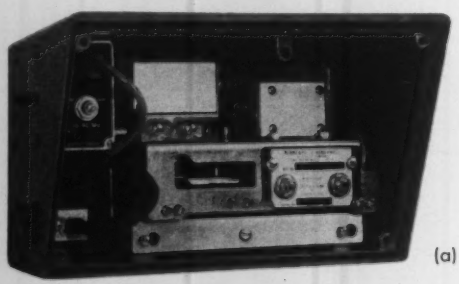
SIGNAL CONVERSION

OPERATION of pressure-to-current transducer is schematically shown in the diagram. The input pneumatic signal is applied to a bellows which deflects a pivoted beam. The beam motion is sensed by a change in the air gap of a detector coil, which changes the inductance of a transistorized oscillator circuit. The net dc signal in the output circuit, which is proportional to the original input pressure, is transmitted to a receiving unit. A portion of the output current is applied to a magnet unit (a pancake-shaped coil suspended in the air gap of four permanent magnets) to rebalance the beam and complete the feedback loop. The comparison of this operation to pneumatic force balance operation is apparent—the input bellows and pivoted beam can be compared to a pilot relay, and the magnet unit rebalances as a feedback bellows in pneumatic operations.

A weatherproof model of a pressure-to-current transducer is shown in photograph (*a*). Explosionproof cases for Class I Group D Division 1 (National Electrical Code) applications are available. An optional housing permits multiple unit relay rack mounting. In all cases, the entire chassis can be removed by quick-connect attachments without disturbing external connections. Plug-in or quick-connect components are used for easy servicing.

The current-to-pressure transducer is almost identical to the P/I unit shown. Either wall, pipe, or valve mounting is provided. An explosionproof case for Class I Group D Division 1 applications is also available. The I/P transducer also provides the quick chassis removal, servicing features, corrosion-resistant construction, and force balance operation characteristic of the pressure-to-current transducer. Photograph (*b*) illustrates the relay rack version of the current-to-pressure transducer. Three units can be mounted on a single relay rack line for space conservation.

Compatibility of electric and pneumatic instruments is indicated by the chart recording. A typical record from a field installation, the particular application has a P/I—I/P transducer loop operating in parallel with an existing pneumatic flow control loop. The records are purposely offset to avoid record cross-over. The outer curve was recorded from electrically transmitted signals, the inner curve from a standard pneumatic transmitter.



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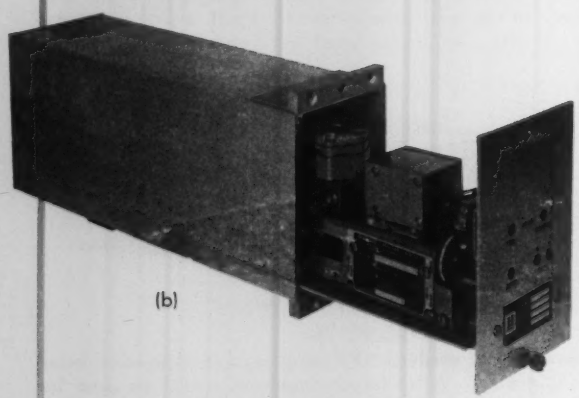

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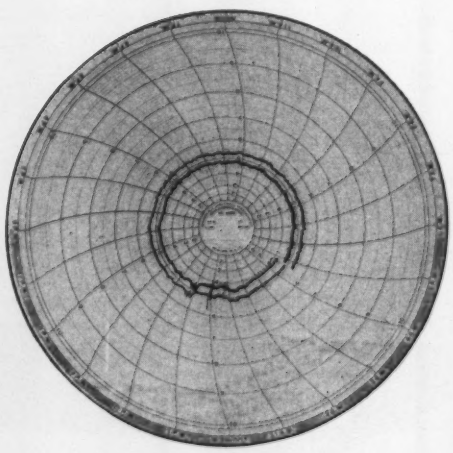


the widespread adoption of electrical systems. Moreover, there was a natural reluctance on the part of some users to substitute the new for the familiar.

In the last few years, however, a number of factors have emerged favoring broader use of electrical control systems. For example, there is the need for increased sensitivity in the measurements of process variables and faster transmission of data. And there is the trend toward centralized control as industrial processes, particularly in the continuous process industries, become larger and more complex. The vast amounts of process intelligence that are now being assembled by data handling systems (which eventually will lead to the use of industrial digital computers in the control loop) require equipment having electrical inputs and outputs.

Both pneumatic and electrical systems have distinct advantages. The opportunities today for combining them in the same measurement and control loop are many and varied. With transducers that convert pneumatic to electric and electric to pneumatic signals, compatible systems can be achieved without difficulty. In fact, the two systems complement each other in many respects.

Transducer Applications

A typical combination system using pneumatic transmitting and control instruments with an electric signal interconnection between the units is shown in *Fig.* 1. The 3-15 psig output of any standard pneumatic device or transmitter is converted into a 4-20 milliampere dc signal by a pressure-to-current (P/I) transducer. This electric signal can be transmitted instantaneously up to 5 miles or more over a single pair of wires to a current-to-pressure (I/P) transducer which reconverts the 4-20 milliampere dc signal to a 3-15 psig pneumatic signal. The required power source or power supply can be conveniently tied in series with the transducers at the receiving end of the circuit. A similar arrangement of transducers also will work between a pneumatic controller and a pneumatic control valve. Where multitransducer loops are in operation, a single power supply is available for all power requirements.

This type of compatible system can be used to great advantage for: Increasing speed of response on critical control loops; long distance transmission; and providing electrical signals for data handling and off-line computer applications with pneumatic control systems. A transducer loop interconnecting pneumatic instruments permits the use of small size transmission wire that can be protected from damage or corrosion in conduit runs. Instrument hook-up changes can be made rapidly and neatly.

Application of P/I and I/P transducers is not confined to a loop configuration where both units are used. These units can also be used individually to provide combination systems for: Data logging and computing functions; pneumatic control valve operation from electric systems; tie-in of pneumatic transmitters with electric systems; and tie-in of electric transmitters with pneumatic systems.

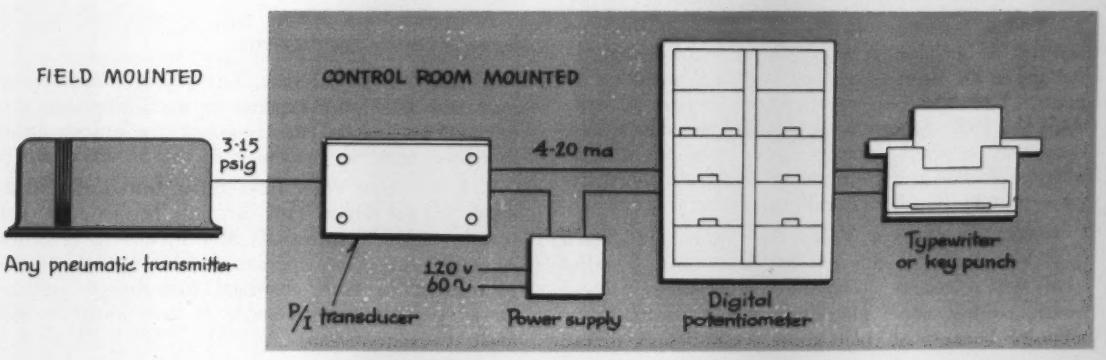
For Example

Increasing Speed of Response. Nearly every plant has one or more "trouble loops"—points at which adequate automatic control cannot be achieved because of time lags inherent in long distance pneumatic transmission lines. These trouble loops are usually associated with extremely fast process changes such as occur in flow and pressure measurements. The usual procedure to meet this lag problem is to field-mount the controller close to the valve. This remedy necessitates multitubing runs for each controller. Further, there is poor accessibility for maintenance and controller setting readjustment.

The addition of transducer units to electrically transmit both the process variable signal and the controller signal will eliminate long distance transmission lags without the need for replacing existing control equipment and permit controller mounting in the control house.

Long Distance Transmission. It is sometimes desirable, or even necessary, to bring in data from

Fig. 2—Modern data logging equipment can be added to existing pneumatic control systems by means of pressure-to-current transducers and equipment to convert the current signal into a proportional voltage signal. A single power source can supply all power requirements for a multitransducer operation.



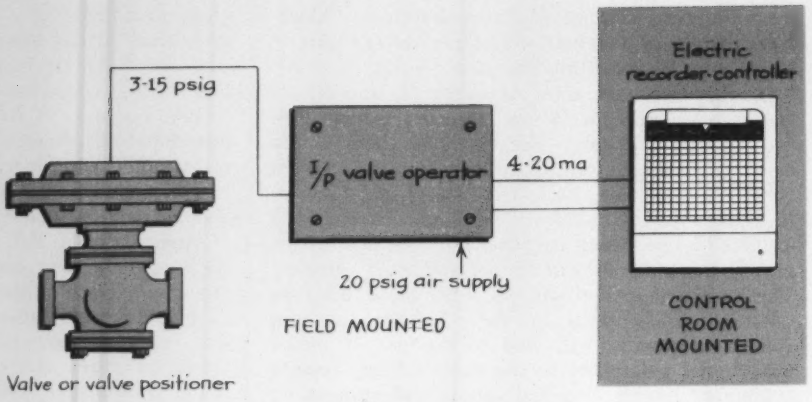


Fig. 3 — Proved performance records of pneumatic control valve operators make the units a preferred form even in some all-electric installations. Current-to-pressure transducer connected in the line as indicated will permit the use of a pneumatically actuated valve in an electrical system.

existing pneumatically controlled process areas to some central location. Information to and from tank farms, outlying recovery or effluent areas, or cooling water supply areas can aid in over-all plant operation. In many cases, the distances involved surpass the capabilities of pneumatic transmission. It is now practical to use a transducer loop system to transmit data 5 miles or more with excellent accuracy.

An additional advantage in using transducers on pneumatic control loops is that in the future data logging and computing can be added to measurement and control loops by merely connecting them to the electrical transmission line. The addition of a 2½-ohm resistor in series with the line automatically supplies a 10-50 mv dc signal for logging or computing. If a larger signal is desired, a proportionately larger resistor is required. This would provide the desirable flexibility for new and advanced techniques.

Data Logging and Computing Systems. Where data handling or computing is anticipated on completely new installations, an all-electric system is generally recommended from an economic standpoint since transducers required with pneumatic systems are eliminated. However, where these are desired on an already installed pneumatic control system, a conversion to electrical signals must be made. *Fig.* 2 schematically illustrates the tie-in of a pneumatic control system with a data logging system. The process variable signal is converted into a dc signal by the identical P/I transducer used in the transducer loop system previously discussed. The output current is sent through a dropping resistor to develop a proportional millivoltage or voltage as an input signal to the data logging equipment. The required power supply is tied in series with the P/I output circuit. As in transducer loop operation, a single power source can be used to supply all power requirements for multitransducer operation in the data handling system.

Pneumatic Control Valve Operation. In actual practice, many of the all-electric control installations will in reality be combination systems. Pneumatic control valve operators will continue to be popular because of their great versatility in thrust, trouble-free operation, and lower initial cost. Thus, from an all-electric measuring and control system, a conversion from electric to pneumatic signals will be required. *Fig.* 3 illustrates such a system. The electric controller output is transmitted through two wires to the field-mounted current-to-pressure transducer which converts the dc signal to a proportional pneumatic signal. No external electric power source is required for the I/P transducer operation.

Pneumatic to Electric Tie-In. Installation of all-electric systems will require a wide variety of transmitting units. In some cases, the electric counterpart of pneumatic transmitters may not be available. When specific functional characteristics, i.e. ranges, material of construction, etc., are available only as pneumatic transmitters, a P/I transducer will bridge the gap between the electric and pneumatic devices.

Electric to Pneumatic Tie-In. In a similar fashion, all-pneumatic systems can frequently benefit by the addition of electric transmitting instruments. Where instrument air is not available, or long distance transmission is involved, an electric transmitter coupled with an I/P transducer will extend the usefulness of the instrumentation system. *Fig.* 4 illustrates process pressure measurement and transmission with a tie-in to a pneumatic recording system by means of the I/P transducer.

▶ Basic Requirements

A combination system will be practical only if it meets certain requirements:

1. Nominal initial cost. Any combination system may add additional expense to the instrument system. The cost of the required transducer units, therefore, must be in line with the benefits gained.

2. Installation ease. Instrument installation costs must be kept down. This can only be achieved with simple wiring connections and mounting facilities. A simple, single box approach with a two-wire interconnection between electrical instruments and no external power requirements at field locations will meet this requirement.

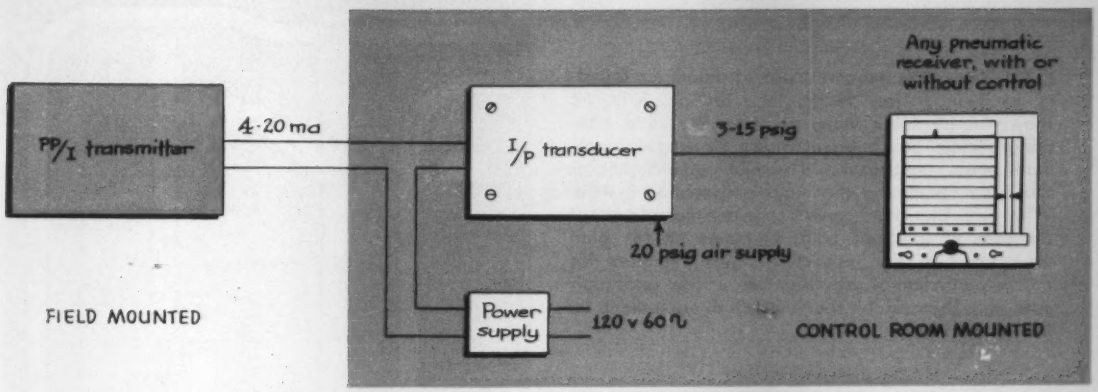


Fig. 4—Emphasizing the role of the transducer in distance transmission, diagram illustrates units as they would be connected where pneumatic recording system is employed. Such an approach can expand potential usefulness of existing instrumentation system by permitting additional instruments to be employed even though distance prohibits use of pneumatic transmission of signals.

3. Low maintenance costs. Transducers must be able to withstand the demanding requirements of field usage. Corrosion resistant construction must be used throughout. All parts must be readily accessible for checking and parts replacement. Long-life components for continuous trouble-free operation are required.

4. High accuracy. Both calibrated and operational accuracies must be high to avoid introducing additional errors in the instrument loop.

Transducer units that meet the requirements of combination systems are available. Examples of units developed by Minneapolis-Honeywell Regulator Co. are shown in the box accompanying this article.

To sum up, the value of combination systems lies in their ability to improve pneumatic instrumentation systems by: Increasing transmission distance from hundreds of feet to several miles; improving speed of response for fast process control loops; permitting compact corrosion-protected transmission lines; and adapting pneumatic systems to data logging systems and evolving modern forms of centralized control.

The operation of electric valves or magnetic amplifiers from pneumatic systems, converting signals from electrical transmitters to pneumatic signals for operation of pneumatic control systems, and operation of pneumatic equipment from electronic potentiometer-type control systems are further examples of the benefits to be derived from combination systems.

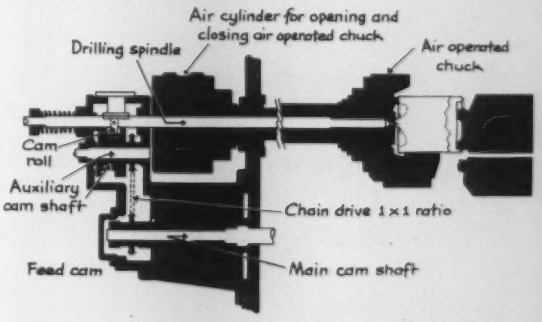
It is the use of transducers that makes possible a flexibility that heretofore could not be realized in putting together systems for specialized control applications.

centering through the headstock

UNIQUE tooling setup enables Cummins Engine Co. to eliminate a separate operation by center drilling aluminum pistons through the spindle while they are being bored, faced, turned and chamfered. Alignment of center drilling and skirt boring is assured because both operations are done simultaneously while the work rotates.

The center drilling operation is accomplished by having a cam driven, spring-loaded drilling spindle connected directly to the main camshaft of the Seneca Falls Machine Co. lathe. The center drilling spindle is in a retracted position when the piston casting is mounted in the chuck. Rotation of the main camshaft is transmitted through a 1:1 ratio chain drive to the auxiliary camshaft and translated into linear motion by a cam roller in the feed cam groove. The cam roller is keyed into the drilling spindle shaft.

As the feed cam turns, the roller forces the drilling spindle (keyed to prevent rotation) forward, thus machining a center in the piston dome. When the centering operation is complete the tooling is automatically disengaged and forced to retract by spring action.



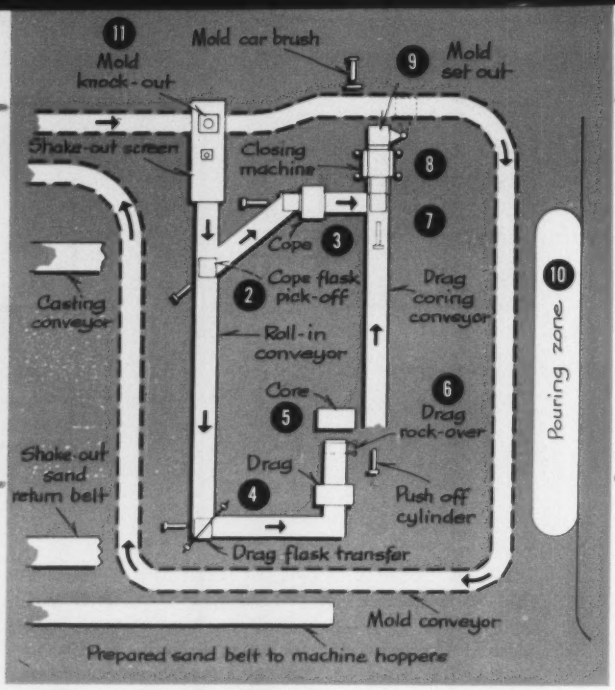


Fig. 1—Diagrams indicate scope of automatic foundry at Brillion Iron Works Inc., Brillion, Wis. As shown in elevation view, an extensive sand handling system has been provided to support automatic mold preparation. The plan view highlights the area containing the mold preparation system. With five operators, molds can be completed at the rate of 240 per hour. Numbers on the plan view refer to the respective figure numbers for the photographs illustrating this article and indicate the location of the illustrated equipment on the plan view.

PRODUCTION FOUNDRY AUTOMATES SAND MOLD HANDLING

METAL FORMING by sand casting is peculiarly adaptable to handling automation—an important factor that has enabled a time-honored production method to keep pace with modern demands for economy. Molten metal and mold sand, two of the major constituents in a foundry operation, have physical properties that enable them to be handled en masse. Mold flasks, a third constituent, can be standardized, thus creating the constant size units that enable repetitive handling of discrete items to be mechanized.

In an ideal position to capitalize on this automation potential are the captive foundries, where lengthy production runs of a standard design can typically be found. That independent foundries can also capitalize on the automation potential is attested to by an installation at Brillion Iron Works Inc. The company has created an integrated system that includes automatic molding machines and automatic sand, flask, casting, and mold handling equipment.

The system provides for a constant movement of cope and drag flasks to their respective mold blowers (automatic blow-squeeze machines that com-

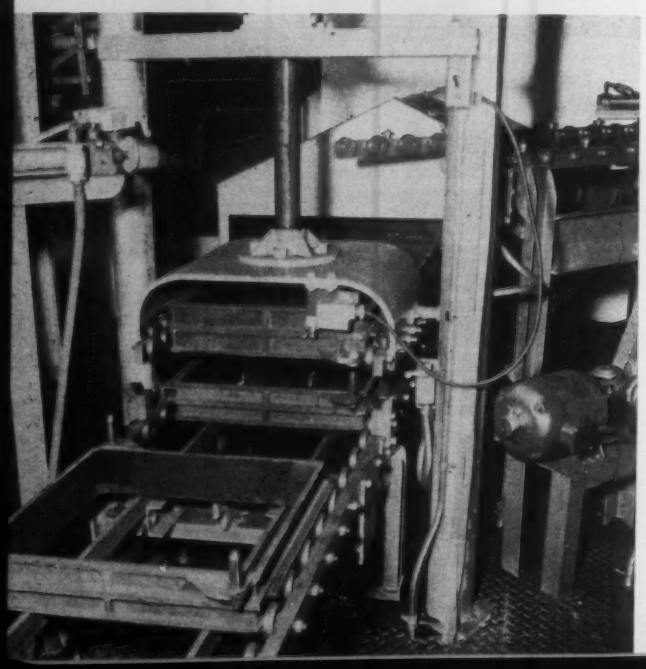
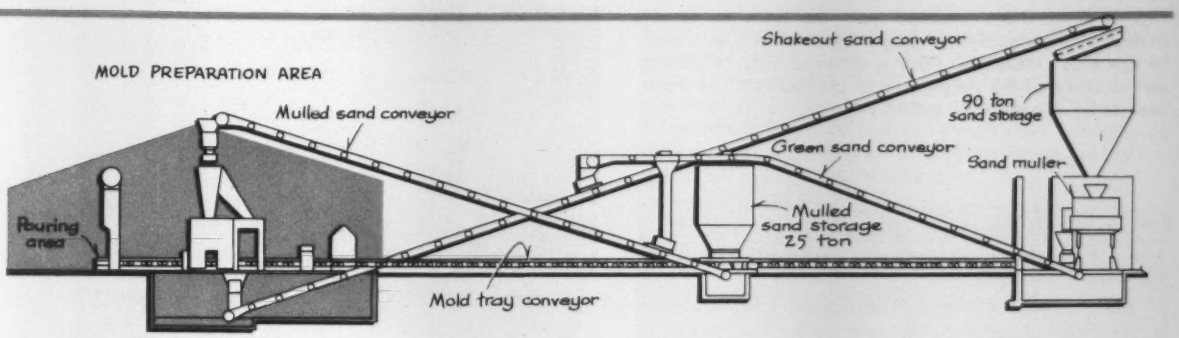


Fig. 2—At the beginning of a mold preparation cycle, cope (top) and drag (bottom) flasks are separated after emerging from a shakeout machine (rear). As combined flasks index into separating position a limit switch is tripped. With this, the cope and drag flasks are parted as a cylinder moves a curved plate assembly upward. The cope flask is supported in the curved plate by conveyor wheels that bear on the flanges of the flask. Through a cam action the separator turns approximately 45 degrees as it rises. At the separator's top position, a limit switch actuates a pneumatic cylinder which pushes the cope flask out of the separator onto the conveyor shown in the top right of the picture. The lower conveyor leads to the drag mold blower and the higher conveyor to the cope mold blower.



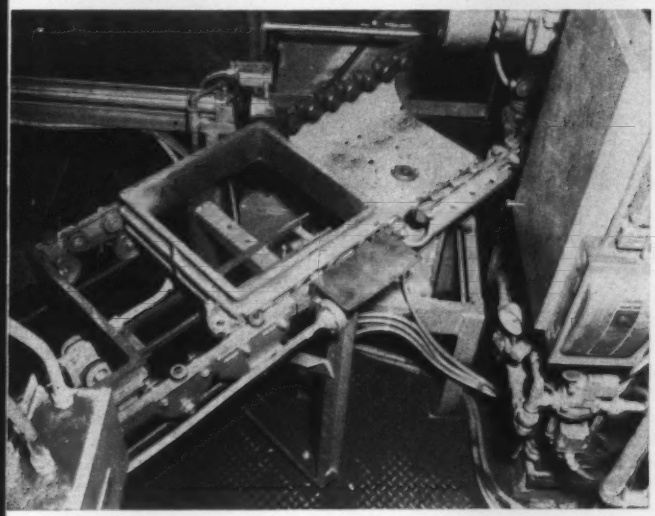


Fig. 3—Conveyor on which cope flask was deposited terminates at cope mold blower. This photograph at entry side of the mold blower shows a turning device containing sections of the wheeled conveyor. The flask is indexed into the turning device, rotated approximately 45 degrees, and pushed into the mold blower by the pneumatic cylinder (left).

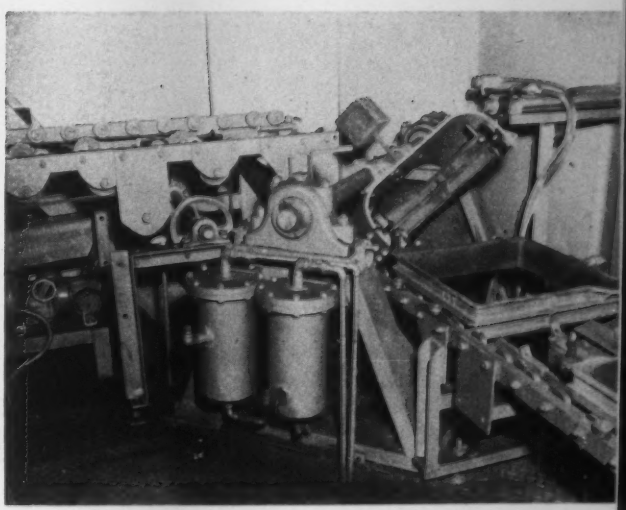
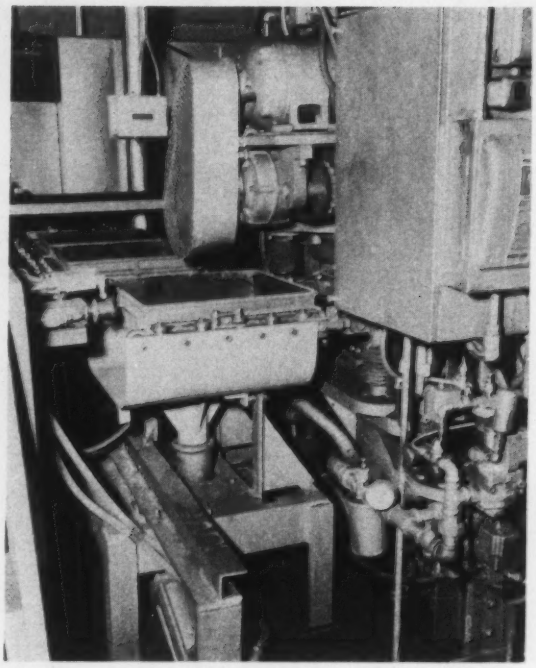


Fig. 4—From the flask separator, drag flask is conveyed to a turnover device (shown in the process of turning a flask over). The axis about which the device turns makes a 45 degree angle with direction of flask movement. With the arrangement pictured, the flask enters the device on the lower conveyor, is turned over, and pushed out of the device onto the upper conveyor at a right angle to the entering direction. Some of the details of a typical belt and pulley system which power the wheeled conveyor can be seen on the upper conveyor.

pact a measured amount of sand around a pattern to form part of the mold) and through a closing station where both halves of the mold are joined. Molds are then transferred to a mold car conveyor which carries them past a pouring station. After a cooling run during which the castings solidify, the mold car conveyor delivers the molds to a shakeout station. Here the castings are separated from the sand and, subsequently, the cope and drag flasks are parted and started through another molding cycle.

The conveyors in the mold preparation area consist of two parallel, rail-like sections on which small wheels are mounted. Flanges on the outside of the drag and cope flasks engage the wheels, suspending the flasks between the rails and supporting the flasks during movement. Though essentially a gravity-type conveyor design, sections of the conveyor are powered by individual V-belt and pulley systems. Along these powered sections, pulleys are spaced at such intervals as to support and cause a traveling V-belt to bear against the desired number of conveyor wheels. The general conveyor design also lends

Fig. 5—Drag flasks proceed from the turnover device to the inlet side of the drag mold blower. As shown in the illustration, the flask is indexed into a turning device, rotated 90 degrees, and pushed into the mold blower by a pneumatic cylinder.



itself to placement of indexing devices between the rails where needed.

Molds are produced at the rate of 240 per hour with a maximum of 5 operators. The equipment is designed to handle an 18 x 18 inch flask with a 5 inch cope height and a 4 inch drag; mold weight is limited to between 35-40 pounds each. Important to casting quality, a uniform mold hardness number between 85 and 90 is maintained with the automatic mold blowers.

The diagrams and pictures accompanying this article highlight the handling aspects of the system for preparing molds automatically.

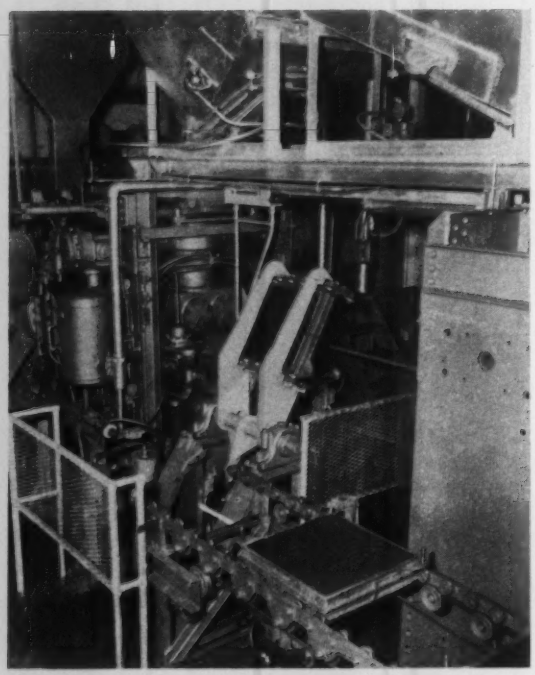


Fig. 6—After the drag mold is made and ejected from the mold blower, it enters a rockover device. With this mechanism the drag mold is again turned over to place the pattern cavity up as it must be prior to the closing operation where the drag and cope flasks are joined. By pneumatic cylinder, the drag is pushed out of the rockover device onto a wheeled conveyor leading to the closing machine. Along this part of the conveyor, cores would be added to the mold if required.

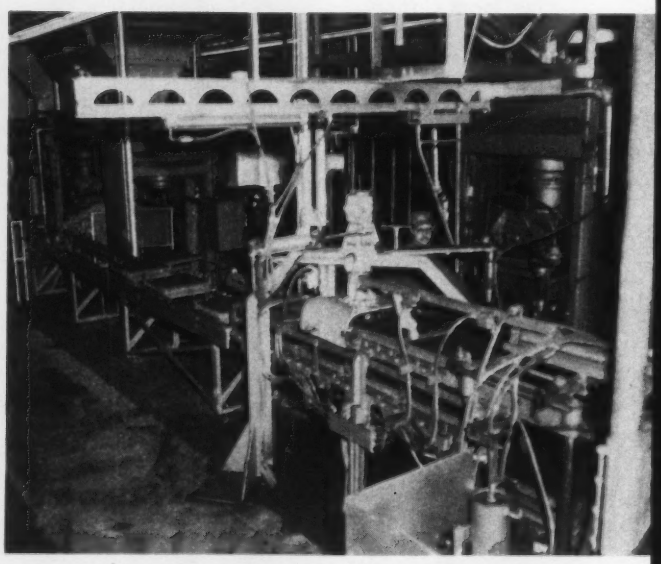


Fig. 7—Illustration shows over-all view of conveyor line at outlet side of the mold blower machines. The superstructure over the conveyor line in the center of the picture is a turning device which receives the cope mold from its blower and discharges the mold onto the upper part of a two-level conveyor. Drag molds travel on the lower level of the conveyor.

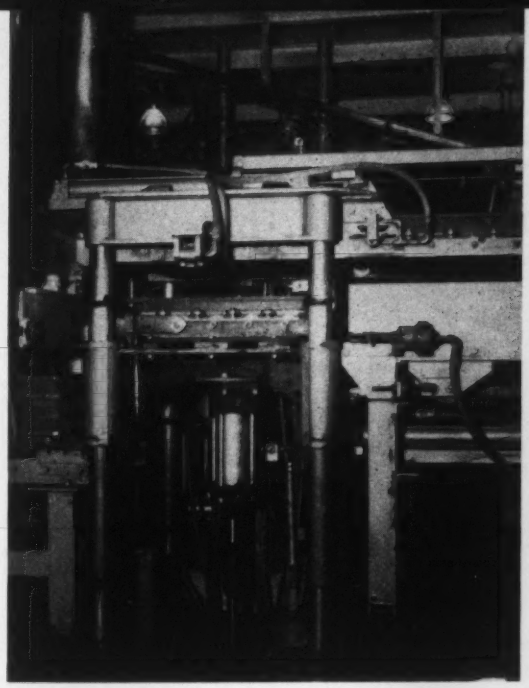


Fig. 8—The two-level conveyor shown in *Fig. 7* terminates at the closing machine. Here the drag mold is indexed onto an elevating device. With a cope mold indexed into proper position above the elevating table, the mechanism rises until drag meets and supports the cope. The conveyor elements which have supported the cope are drawn away from the flanges on the cope flask and the complete mold is lowered and ejected onto a short conveyor. Limit-switch controlled pneumatic cylinders provide the actuation for the various actions of the closing machine.

Fig. 9—Completed molds are transferred from the wheeled conveyor to the mold car conveyor by an overhead pickup device. Pneumatically operated, the device grasps the mold, raises it a few inches, and rotates to deposit it on the carrier. Interlocked motions provide that two molds are placed on each car of the conveyor as it is indexed past the transfer point.

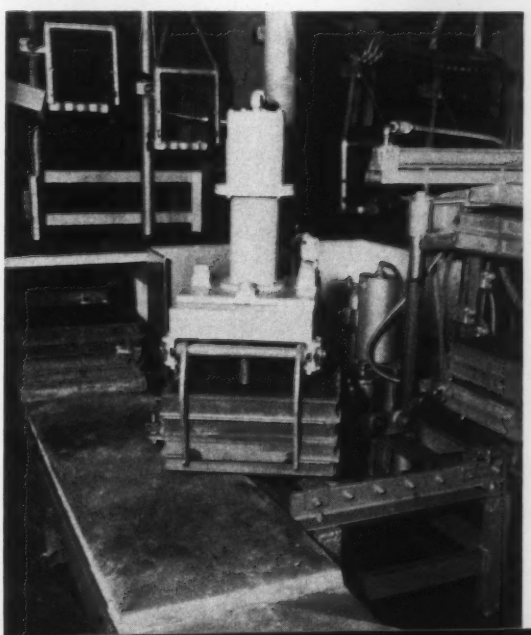


Fig. 10—Weights suspended from an overhead conveyor are automatically set on the molds as the overhead conveyor dips down at the pouring zone. The overhead and mold car conveyors index together until subsequently the overhead conveyor raises, the weights are removed, and mold car conveyor commences the run along the cooling leg of its cycle.

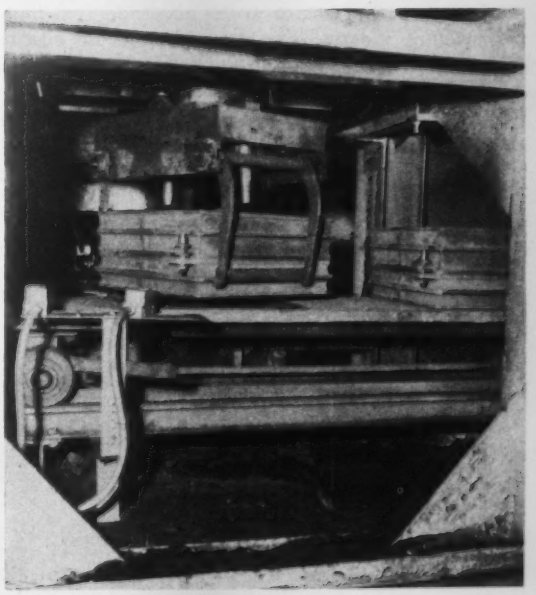


Fig. 11—At the end of its cooling run, mold car conveyor passes beneath a handling device at the input side of the mold shakeout machine. Limit switch actuation causes a set of pneumatic clamps to grasp the mold, raise it from the car, rotate 90 degrees, and deposit the mold on a wheeled conveyor. A punch forces the sand and casting from the flask onto a shakeout screen. The flask then commences another preparation cycle as it moves into the separator mechanism. Castings are conveyed to a separate area where they are sprued and sorted. Sand is returned to the storage system for reuse.

MULTIOPERATION WOODWORKING MACHINE SPEEDS STEPLADDER PRODUCTION

PRODUCTION of side rails for wooden stepladders involves the performing of several types of operations on prepared stock. For example, multiple dadoing produces slots in the rails at angles such that subsequently assembled steps will be horizontal with the ladders opened; drilling of holes in the rails prepares them to receive tie bars and top plate assemblies; and a trimming operation is required to cut the side rails to length at the proper angle. An operation which finishes the exposed lower feet of the side rails may also be necessary.

All of these operations are performed automatically in a machine designed and built by Union Tool Corp. and installed at Goshen Churn & Ladder Co. The unit processes side rails in matched pairs; for short ladders, two pairs of side rails are produced simultaneously.

In operation, precut boards are stacked in a magazine at the input end of the machine, *Fig.* 1. Side rails for one 12-foot ladder, or for each of two 5-foot ladders, can be produced. A system of parallel feed chains containing dogs at spaced intervals engages the bottom pair of boards in the magazine each time the machine indexes. The dogs advance the boards through each workstation to the discharge end of the machine. Because of the position of the magazine with respect to the machine frame, the boards are picked up from the magazine and advanced through the machine at the proper angle to produce dadoed slots and to trim the ends of the boards with parallel dado cutters and trimming saw blades.

In the first operation, a pair of boards is passed through a set of trimming saws that cuts the rails to length. Next, multiple slots are dadoed in the rails with a system of 22 dado heads (11 top and 11 bottom).

After the rails have been dadoed, they are advanced to a station where they are positioned for drilling. A frame, mounted at the angle of the boards, lowers and feeds a set of drillheads to the work. Drills then produce tie bar and top plate mounting holes in both rails. Finishing of the rail ends is also performed with the rails clamped in the station. When drilling and finishing have been completed, the rails are unclamped and indexing continues until the rails are discharged from the machine, *Fig.* 2.

Flexibility of tooling has been provided in the machines. For example, up to 24 electric motors and drillheads can be mounted in various positions to produce different patterns of holes. Each motor is controlled by an individual switch permitting that motor to be deactivated at will. Two or four trim saws may be used, depending upon the length of rail being processed. Tooling depth adjustments are provided where necessary.

Maximum thickness of side rail stock that can be handled in the machine is $1\frac{1}{8}$-inch; maximum width is $3\frac{1}{2}$-inches. Output of the machine is 10 pairs of long or 20 pairs of short side rails per minute.

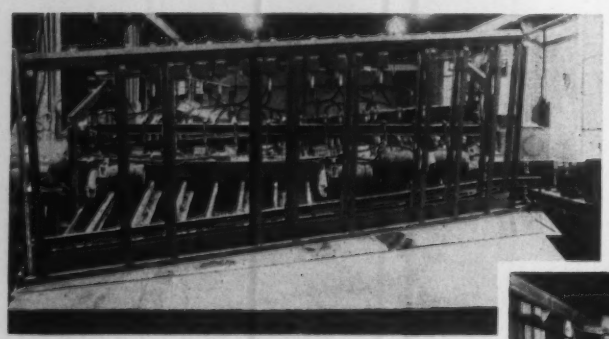


Fig. 1—Precut boards are stacked in angled magazine, foreground, for processing into side rails for wooden stepladders. Production rate of automatic machine is 10 pairs of long or 20 pairs of short side rails per minute.

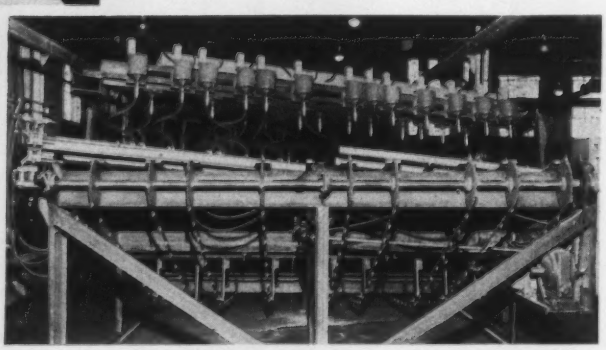
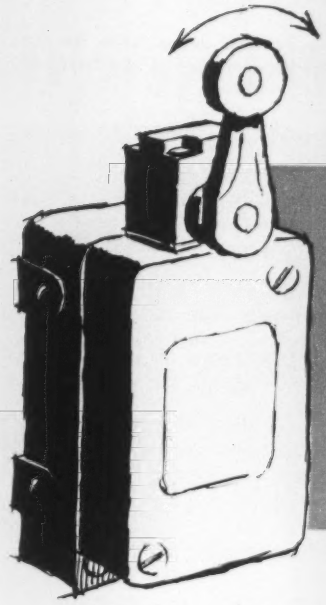


Fig. 2—View of discharge end of machine shows chain system that advances boards in pairs through machine. Electric motors are connected by flexible shafts to drillheads that produce holes for tie bars and top plates. Machine is inclined upward toward its discharge end so that high stacks of finished material can be accumulated.



Versatile, precision snap-acting switches are available in a variety of basic forms to satisfy different application requirements. A wide choice of actuators and enclosures further broadens the range of applicability of these components in the control circuits of automatic production facilities. To foster mutual understanding between suppliers and users, and to assist users in specifying the proper components, AUTOMATION presents the first of a series of data sheets covering the provisions of NEMA Publication IC 3-1959, "Precision Snap-Acting Switches."

DEFINITIONS OF SWITCH TERMS

OF THE various types of electrical components found in the control circuits of modern automatic production machines, precision snap-acting switches are among the most common. Used widely throughout industry, typical applications for these components include sequencing multiple machine actions, sensing the presence or absence of parts in magazines or fixtures, and sensing the fully extended or retracted positions of movable machine elements such as slides and piston rods.

Other applications call for their use in detecting the breaking or depletion of material being fed to processes, and in continuously inspecting quality characteristics of materials and products. An example of the latter is in the checking of cotton threads for knots and lumps while the threads are being processed.

A variety of actuators can be fitted to precision snap-acting switches or to their enclosures. They include wire and leaf spring, hinged leaf, toggle, plunger, and rotary arm types. Some of the actuators may include rollers which are useful when there is sliding action between the actuator and the force-exerting member at the actuating point.

Proper selection of a precision snap-acting switch usually involves the determination of several factors. Among these are: 1. Electrical rating in current or horsepower at specified voltages which may be ac or dc. 2. Contact arrangement, such as SPST, SPDT, etc. 3. Mechanical considerations, such as operating and releasing forces, pretravel, and overtravel. 4. Type of switch. This may be open type, skeleton type, or the type encased within an envelope. Protective enclosures may also be specified. 5. Special requirements, such as sealed construction or plug-in style. 6. Space available for mounting the switch and bringing leads to its terminals.

Considering the variety of types of precision snap-acting switches, actuators, and types of enclosures available, and the range of electrical characteristics obtainable with these components, the need for a common language of terms, definitions, and symbols is apparent.

Aware of such a need, the Industrial Control Section (Precision Snap-Acting Switch Group) of the National Electrical Manufacturers Association has issued Publication IC 3-1959. This publication combines pertinent definitions from NEMA Standard 6-24-1957 with suggestions for the proper application of industrial limit switches taken from NEMA Authorized Engineering Information 1-13-1959. This first part of a series covering the provisions of IC 3-1959 is devoted to definitions.

General

IC 3-1.01. A SWITCH is a device for making, breaking, or changing the connections in an electric circuit.

IC 3-1.02. SNAP ACTION is a rapid motion of the contacts from one position to another position, or their return. This action is relatively independent of the rate of travel of the actuator.

IC 3-1.03. A PRECISION SNAP-ACTING SWITCH is a mechanically operated electric switch having predetermined and accurately controlled characteristics, and having contacts other than the blade and jaw, or mercury type, where the maximum separation between any butting contacts is $\frac{1}{8}$ inch. A precision snap-acting switch consists of a basic switch used alone, a basic switch used with actuator(s), or a basic switch used with actuator(s) and an enclosure.

IC 3-1.03A. A BASIC SWITCH is a precision snap-acting switch of either the open type, skeleton type, or the type encased within an envelope. A basic switch is normally used within a protective enclosure or is used as a component.

IC 3-1.04. A MOMENTARY CONTACT SWITCH is a switch which returns from the operated condition to its normal circuit condition when the actuating force is removed.

IC 3-1.05. A MAINTAINED CONTACT SWITCH (RESET SWITCH) is a switch which remains in a given condition until actuated to another condition, which is also maintained until further actuation.

IC 3-1.06. An ENCLOSURE is a supplemental protection for the basic switch but does not necessarily form an integral part thereof.

IC 3-1.07. An ACTUATOR (SWITCH ACTUATOR) is the mechanism of the switch or enclosure which, when moved as intended, will operate the contacts.

IC 3-1.08. An AUXILIARY ACTUATOR is a mechanism which may be attached to a switch to modify its characteristics.

IC 3-1.09. OPERATING FORCE is that straight line force in the designated direction applied to the actuator to cause the switch contacts to snap to the operated contact position.

IC 3-1.10. The OPERATED CONTACT POSITION of a switch is the position to which the contacts move when the actuator is traveled to or beyond the actuator operating position.

IC 3-1.11. ACTUATING POINT is the point on an actuator at which operating force is normally applied.

IC 3-1.12. PRETRAVEL is the distance or angle through which the actuator moves from the actuator free position to the actuator operating position.

IC 3-1.13. OPERATING POSITION is the position of the actuator at which the contacts snap to the operated contact position.

IC 3-1.14. OVERTRAVEL is the movement of the actuator beyond the operating position.

IC 3-1.15. The OVERTRAVEL LIMIT POSITION is that position of the actuator beyond which further overtravel would cause damage to the switch or actuator.

IC 3-1.16. TOTAL OVERTRAVEL is the distance or angle through which the actuator moves when traveling from the actuator operating position to the overtravel limit position.

IC 3-1.17. TOTAL TRAVEL is the sum of the pretravel and total overtravel.

IC 3-1.18. OPERATING TORQUE is that torque which must be applied to the actuator to cause the moving contact to snap to the operated contact position.

IC 3-1.19. CONTACT FORCE is the force exerted by the moving contact on a stationary contact.

IC 3-1.20. The BREAK DISTANCE of a switch is the effective open gap distance between the stationary and movable contacts.

IC 3-1.21. REPEATABILITY is the ability to consistently maintain the original operating characteristics.

Momentary contact switches

IC 3-1.22. NORMAL CONTACT POSITION is that position of the contacts which exists when no operating force is applied.

IC 3-1.23. FREE POSITION is the initial position of the actuator when there is no external force (other than gravity) applied on the actuator and the switch is in the specified position.

IC 3-1.24. RELEASING FORCE is the value to which the force on the actuator must be reduced to allow the contacts to snap from the operated contact position to the normal contact position.

IC 3-1.25. The FORCE DIFFERENTIAL is the difference between operating force and the releasing force.

IC 3-1.26. RELEASING TORQUE is the value to which the torque on the actuator must be reduced to allow the contacts to snap from the operated contact position to the normal contact position.

IC 3-1.27. TORQUE DIFFERENTIAL is the difference between the operating torque and the releasing torque.

IC 3-1.28. RELEASING POSITION is that position of the actuator at which the contacts snap from the operated contact position to the normal contact position.

IC 3-1.29. MOVEMENT DIFFERENTIAL is the distance or angle from the operating position to the releasing position.

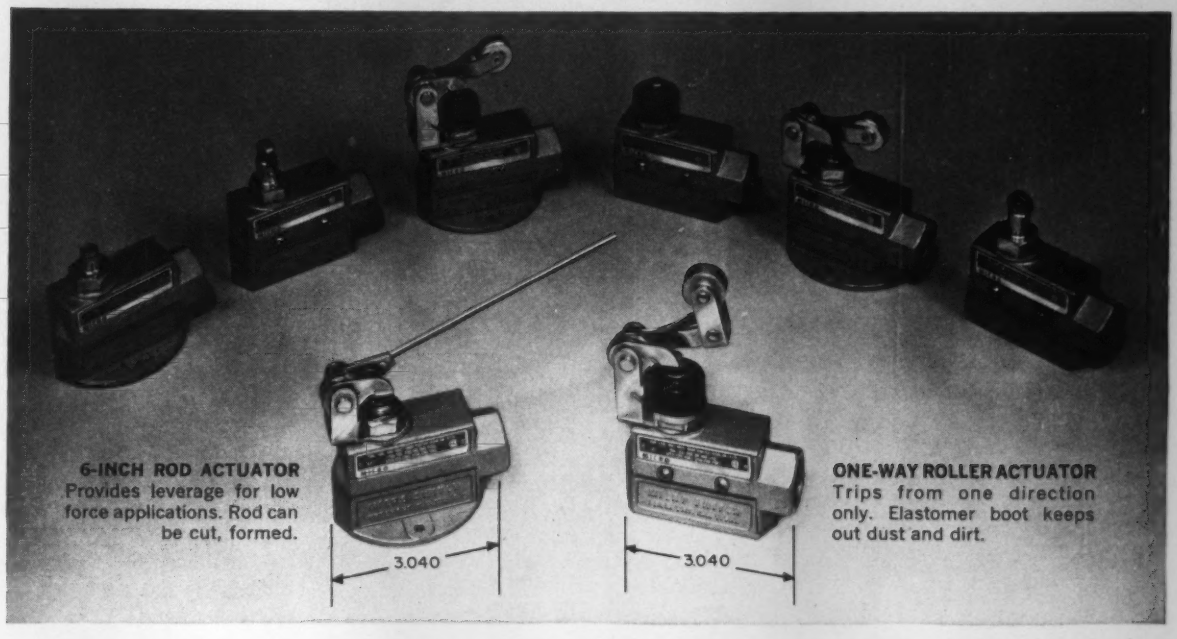
Maintained Contact Switches

IC 3-1.30. RESETTING FORCE is the force which must be applied to the resetting mechanism to cause the contact to snap from one position to another.

IC 3-1.31. RESETTING TORQUE is that torque which must be applied to the resetting mechanism to cause the moving contact to snap from one position to another.

IC 3-1.32. RESETTING POSITION is that position of the resetting mechanism at which the moving contact snaps from one position to another.

MICRO SWITCH Precision Switches


6-INCH ROD ACTUATOR
Provides leverage for low force applications. Rod can be cut, formed.
3.040
3.040
ONE-WAY ROLLER ACTUATOR
Trips from one direction only. Elastomer boot keeps out dust and dirt.

Two new actuator designs make "E6" and "V6" enclosed switch family even more versatile

MICRO SWITCH now offers *eight* actuator designs in its line of "E6" and "V6" enclosed, snap-action precision switches. The new one-way roller lever is ideal for machine tool applications that require a slide to actuate the switch, override it, and *not* actuate it on the return stroke. The new rod actuator is designed for low-force applications such as sorting and counting. The six-inch rod can be cut or formed to adapt to the user's specific requirements.

These remarkably compact switches are available for side mounting (E6), or bottom mounting (V6). They are easy to wire, well sealed, long lasting (through millions of operations), and will handle #0 and #00 contactors. Side mounting switches are available with #8 as well as #6 mounting screws. Send for Catalog 83.

CHARACTERISTICS		
	6-inch Rod	One Way Roller
Operating Force	2 to 5 oz.	8 to 20 oz.
Release Force	2 oz. min.	6 oz. min.
Pretravel	.718 in. max.	.234 in. max.
Differential Travel	.229 in. max.	.006 in. max.
Overtravel	.838 in. min.	.219 in. min.
Vertical Adjustment Field	1238 positions through 225°	990 positions through 180°
Horizontal Adjustment Field	8 positions through 360°	All positions through 360°

All "E6" and "V6" switches have a single-pole, double-throw contact arrangement. They are listed by Underwriters' Laboratories at 15-amps, 120-, 250-, or 480-vac; ½-amp, 125-vdc; ¼-amp, 250-vdc.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

Circle 683 on Page 19

"THE NATIVE HOLLANDER WEARS WOODEN SHOES."

A Bell Telephone Laboratories experiment in noise appraisal

"The native Hollander wears wooden shoes."

"Nebraska has no seacoast."

"The daisy is a common wildflower."

As these syllables, words and sentences come in over the telephones, stand-ins for millions of Bell System subscribers rate them for clarity of reception.

From these tests, Bell Telephone Laboratories engineers determine what is objectionable noise, and work to minimize it in telephone circuits. They begin by tape recording background noise associated with working telephone circuits. Test statements of appropriate length and content (such as those above) are read onto a second tape, and both are fed onto the test circuit under carefully controlled conditions. A third tape, of normal room noise, is played through a loudspeaker in the test lab.

Several hundred listeners, meeting in small groups several times a day for weeks at a time, are then asked to rate the effect of noise on transmission of the various simulated telephone calls.

For the Bell System, the results of the study will become part of the over-all transmission objectives. At Bell Laboratories, they will influence apparatus and systems development work.

Noise is a major distraction of modern day living. It is also an enemy of the Bell System. In a telephone receiver during a call, it might be power line hum, switching or thermal noise, or perhaps atmospheric static. Bell Laboratories spends a great deal of time, effort and money to keep this extraneous noise from becoming annoying and to assure you of a trouble-free connection.

BELL TELEPHONE LABORATORIES

World center of communications research and development

AUTOMATION

new equipment

Machines and plant equipment for more automatic operations
For detailed information and literature, use card page 19.

Feeder, Counter, and Stacker Handles Bulky Parts

DESIGNED to receive lightweight plastic boxes directly from a molding press, machine automatically feeds, orients, counts, and stacks the boxes in groups of 25 at a rate of 2 stacks per minute. Completed stacks are discharged automatically onto an inclined surface that leads to an inspection and packing area. Unit is manufactured by **Vibron Div., Burgess & Associates Inc.**, 3790 W. 150th St., Cleveland 11, Ohio.

In operation, parts are dropped into the 40-inch diameter bowl of a pneumatically operated vibratory feeder. They then travel upward in random orientation on a helical track at the outer edge of the bowl. The final section of the track contains tooling that permits only properly oriented parts to proceed to a stacking chute. Other parts are rejected back to the bowl for recirculation. Rejection of these parts is accomplished by an air blast from the exhaust ports of the vibratory unit that actuates the bowl.

Oriented parts that drop into the stacking chute pass and actuate a photoelectric sensing head. Each time a box passes this device, an electrical signal is generated. The signal, after amplification, is used to advance the arm of a stepping switch. When the switch is advanced to its 25th step position, three actions occur: 1. A solenoid closes off the stacking chute so that any subsequent parts in transit are blocked. 2. A valve is actuated that places the vibratory bowl in a nonfeed state. 3. A timer is started. The function of the timer is to delay the action of an air cylinder that ejects the stack until the last part has been stacked. This delay is about 30 milliseconds.

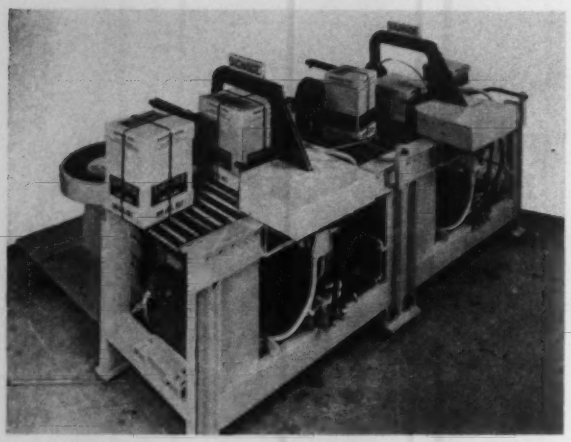
At the end of the outward stroke of the ejecting cylinder, a limit switch is actuated that resets the stepping switch to its starting position. Thus, the stacking chute opens, the vibratory bowl is restored to a feeding state, the timer is reset, and the ejecting cylinder is returned. The next stacking cycle begins immediately. A feature of the equipment is independent valve control of both frequency and amplitude of bowl vibration for optimum feeding conditions with minimum air consumption. In the application described, approximately 6 scfm of air are consumed in normal operation.

Circle 401 on Page 19

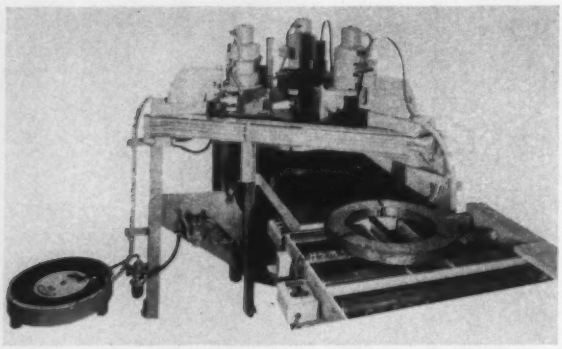
Strapping Machines

Item 402

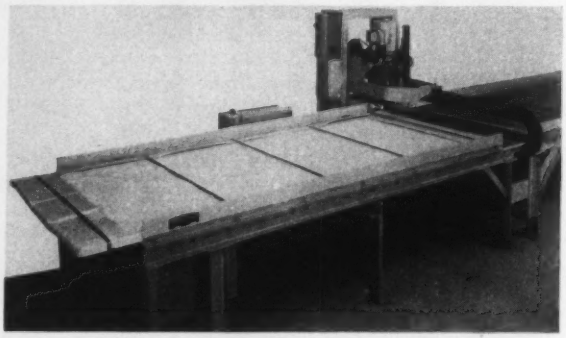
Line of automatic and semiautomatic steel strapping machines is of straightforward mechanical design with power supplied by standard electric motors. A unit can be mounted in any position and straps can be applied in either a vertical



In this application, unit is cross-strapping nail cartons in mixed sizes. There are virtually no limitations on the shape or firmness of bundles and packages that can be strapped.



Setup is applying three straps simultaneously to strip steel coils at the rate of 1000 coils per hour. The 1¼-inch overlap of strap ends under seal is positively controlled.



Five straps are being applied to these plastic sheet packs, but the number of straps per pack is optional. During the strapping cycle, there is no movement of the bundle or package relative to the machine.

or horizontal plane. It can be mounted flush with the side of a conveyor, or several machines can be ganged, so that multiple straps can be applied automatically and simultaneously to a single package. Strap sizes are ⅜ by 0.010-inch to ¾ by 0.035-inch. Adjustment of strap tension can be from 50 lb minimum to the maximum tensile strength of the strap—maximum tension with a 3 hp motor is 1600 lb.

Model M20 has a strap feeding and strapping speed of 196 fpm. A 1¼-inch overlap of strap ends under seal is positively controlled. Seals may be placed at any flat portion of the periphery of a package. During the strapping cycle there is no movement of the work relative to the machine. The only mechanical adjustment required is a tension setting adjustment; but this remains constant once it is set. Wearing parts such as cutters and sealing jaws can be easily replaced. **Signode Steel Strapping Co.**, 2600 N. Western Ave., Chicago 47, Ill.

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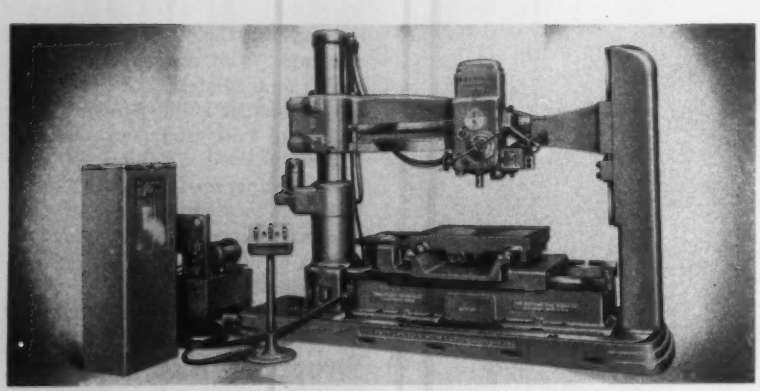


Tape-Controlled Positioning Table

Item 403

Designed primarily for use with company's radial drill, numerically controlled positioning table can support heavy workpieces, positioning the work anywhere within a 30 by 20-inch working area with an accuracy of ±0.00025-inch on either axis, repeating a position within ±0.00005-inch. The table travels automatically from one program position to the next, moving simultaneously on both axes at the same speed from start to finish of movement, with no over travel. Unit has an endless punched tape which makes it suitable for job-lot runs, either small or large. With the endless punched tape, as soon as one workpiece is complete the machine is ready for the next without rethreading of the tape. Intermediate positions on the endless tape cannot be lost, since once the hole pattern is punched, it remains in proper relationship for the life of the tape.

During operation, the punched tape is read pneumatically by a flow of low pressure air. This air-passing through the holes in the tape, actuates a series of switches, signal-

Circle 684 on Page 19→

GAYLORD TECHNOLOGY
DIGS UP NEW PACKAGING IDEAS FOR YOU

Whether prospecting for new packaging ideas or simplifying existing containers, you strike pay dirt when Gaylord works with you. Gaylord sifts your packaging operation . . . then applies the experience of its many integrated services in recommending the right packaging for your need.

Your G-man knows how to make your packaging pan out. Call him . . . for corrugated boxes by the million or engineered packaging.

GAYLORD
CONTAINER CORPORATION

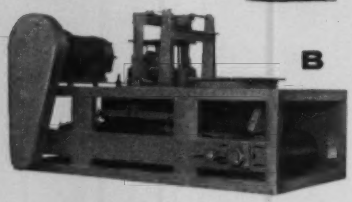
Gaylord Boxes

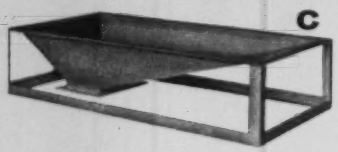
HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

DIVISION OF **Crown Zellerbach Corporation**

UNITIZED WEIGHER-FEEDER

Building-block design gives custom-made utility at an off-the-shelf cost





UNITIZED construction makes the W-C Weigher-Feeder readily adaptable to practically any processing setup. Components are standardized, proven and interchangeable . . . pre-engineered with virtual "plug-in" simplicity.

A The UPPER FRAME controls material input, is supplied with a rotary feeder, sliding gate, vibratory feeder or other mechanism matched to material and flow requirements.

B The CONVEYOR FRAME, where material is weighed, includes a complete conveyor section, weighing pan and transmitter with integral tare adjustment. W-C's system of flexure mountings assures accurate measurement despite uneven loading or pile-ups. There are no knife-edges, beam pivots or other points of concentrated wear to affect accuracy.

C The LOWER FRAME is optional; can be a simple chute as shown.

In addition, the W-C Weigher-Feeder is designed to handle such instrument-controlled functions as flow totalizing, recording, programming, and material proportioning. Units are also available for installation on existing conveyors.

Complete information is given in Catalog 12. Write for a copy

W-C

S.A. 1667

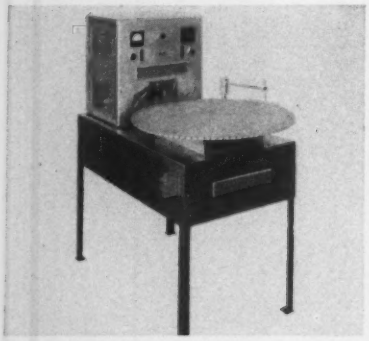
WEIGHING and Control COMPONENTS, Inc.

206-C Lincoln Ave., Hatboro, Pa.

Circle 685 on Page 19

ling where the positioning table is to move to arrive at the next working location. An electronic control system then actuates the machine's hydraulic system to perform the required travel. During the loading of the machine, workpieces are located on the positioning table by means of stop-plates which are installed at the edge of the table. Using blocks of prescribed length between the stop-plates and the workpieces, the operator can easily locate the work. **American Tool Works Co.**, Pearl St., Cincinnati 2, Ohio.

Circle 403 on Page 19

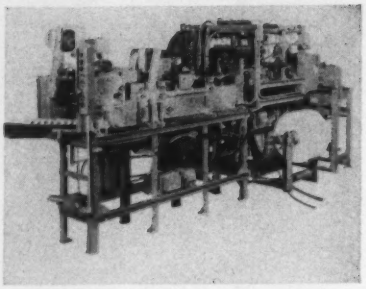


Induction Heating Unit

Item 404

Floor-mounted induction soldering and brazing machine is suitable for operations such as capacitor lead and bracket soldering, can soldering, crystal soldering, and relay and switch contact soldering and brazing. Soft soldering operations, such as those applied to capacitor leads, are handled at a rate in excess of 3000 per hour. Machine consists of a high frequency induction heating generator and a variable speed motor-driven turntable. The heater and turntable are electrically interlocked. Turntable diameters can be either 18 or 36 inches; turntable speeds range from 1/6 to 10 rpm. A feature of the turntable is an automatic kick-off arm which ejects soldered or brazed assemblies after a sufficient cooling time on the turntable. Various holding jigs and heating coils are also available for handling numerous shapes and types of assemblies. **Reeves Electronics Inc.**, 609 W. Lake St., Chicago 6, Ill.

Circle 404 on Page 19

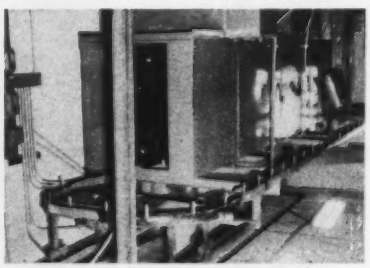


Automatic Packager

Item 405

Soft, flimsy products can be packaged with automatic wrapping machine. Equipment can automatically fold and seal the product in glassine or foil taken from rolls. It can also stack and count the finished pieces. In the illustration shown, surgical sponges (gauze pads) are being packaged in sterilizable glassine. There is a double drug fold on three sides and the package is glue sealed. Production rate is 60 sponges per minute. Another model in line provides a clear film on front of package and a paper or board backing. **Laukhuff-Pratt Mfg. Co.**, Milwaukee, Wis.

Circle 405 on Page 19



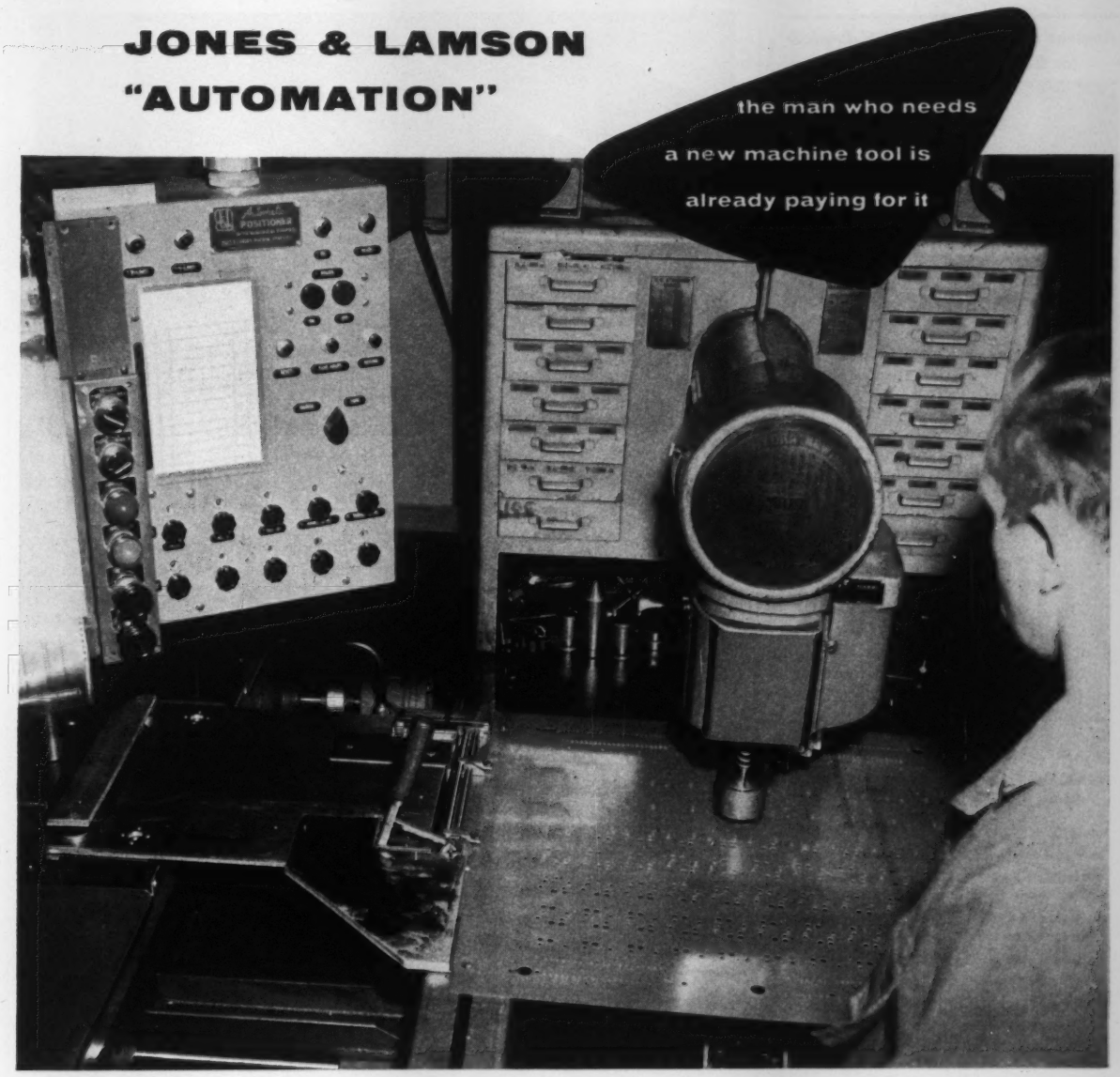
Ball Trolley Conveyor

Item 406

Enclosed track type overhead conveyor features a trolley which rolls on a circulating path of steel balls passing between the trolley and track. The steel balls, which fit loosely in vertical and horizontal annular grooves around the trolley, roll the trolley at speeds up to 60 fpm. Vertical and horizontal turns are made by short radius bends in the track without the aid of sprockets or wheels. Unit is especially suitable for use in ovens, as it does not require lubrication. **General Automatic Transfer Co.**, 911 Craig Dr., Kirkwood 22, Mo.

Circle 406 on Page 19

JONES & LAMSON "AUTOMATION"



This Tape Controlled Setup Punches 1483 holes – of 11 different sizes – in just 85 minutes

How's this for small lot automation? The problem is to produce 50 parts, each having 1483 holes of 11 different sizes. Hole location must be ±.002″. Delivery — 2 weeks.

J & L's numerical control positioning table, applied to a standard punch press, does the job with minimum lead time, production time, and cost. Here's how:

The entire tape programming for this complicated part takes only 15 hrs. There are no fixtures, templates, or dogs to be made and set. No gang tooling to prepare. No appreciable setup time.

The operator simply inserts the prepared tape, locates the work piece and pushes a button. The positioning table is then automatically controlled in any pre-arranged, random pattern. Therefore there are only 11 tool changes for the 11 sizes of holes. And — this unit tells the operator when and what tool to change.

A completed part comes off the machine every 85 minutes. Changeover for other jobs is just a matter of changing tapes and tools.

Investigate how tape control can help increase the efficiency of *your* operation. Write to Jones & Lamson Machine Company, 536 Clinton Street, Springfield, Vermont.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

Circle 686 on Page 19

Another RCA AUTOMATION Product for Better Materials Handling

Low cost automatic

RCA ROTARY HOPPER

Compare the cost and features of these new RCA Automatic Rotary Hoppers, and you'll see why they are gaining such rapid acceptance! They provide every needed operating feature, yet are offered at remarkably low prices . . . beginning at $265, f.o.b., Detroit.

Features:

- **High-speed—up to 20,000 parts per hour.**
- **Handles cylindrical, rectangular, headed disc shaped and other parts.**
- **Parts orientation performed by feed track, not the bowl.**
- **Feed tracks easily changed by loosening one screw.**
- **18", 24", 30" bowls available.**
- **Rugged construction—cast-iron frame; driving mechanism supported by heavy duty self-aligning bearings.**
- **Standard gear-head motor.**
- **Safety-slip drive protects parts and equipment.**
- **Price includes cleats on selector ring and mounting block for tracks.**
- **Demand-control mechanism and wide variety of discharge tracks furnished at modest extra cost.**

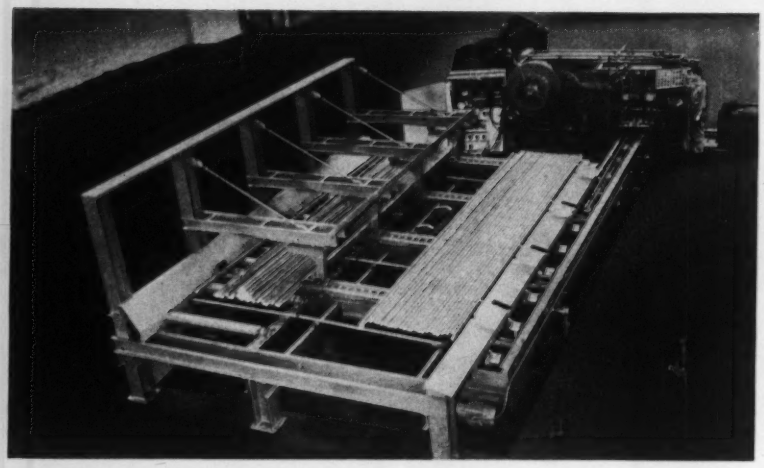
Write today for complete information on low-cost RCA Rotary Hoppers. To permit analysis of your needs, send two samples of each part to be handled, and indicate required production rates. Details of other RCA Automation Equipment available on request.

RCA Tmk(s)®

RADIO CORPORATION of AMERICA

INDUSTRIAL AND AUTOMATION DIVISION
12611 Arnold Ave., Detroit 39, Mich.

Circle 687 on Page 19



Bar Shearing Setup

Item 407

Equipment is capable of automatically shearing high tensile material, two pieces at a time. It features an automatic disposal for scrap ends of bars. In operation, open bundles of bar steel are loaded on a yard conveyor and transferred automatically onto a cross-chain magazine. With the use of an adjustable scraper arrangement, bundles in the magazine are broken down to single thickness for discharge onto a feed conveyor. Two bars feed off the conveyor to a predetermined retractable length gage which automatically energizes a clutch on the shear, making one cut. As the bars are used up, two more bars are automatically discharged to the feed conveyor. Fifty pieces of cut material per minute are produced.

As the pieces are cut, horizontal chains carry them to drop-off chutes for deposit into reciprocating tote boxes that automatically stack the cut pieces. After each tote box is filled, it is moved forward by an empty box which starts filling without any interruption of the shear cycle. The take-away system will accommodate three full boxes and three empty boxes which can be placed in position or removed without stopping the cutting operation. **Hill Acme Co.**, 1201 W. 65th St., Cleveland 2, Ohio.

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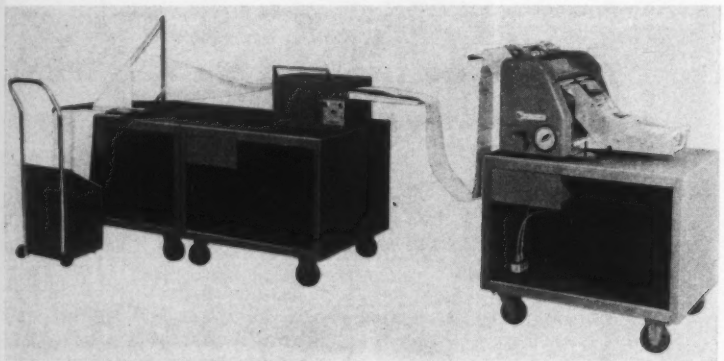

Postcard Billing System

Item 408

Portable equipment is designed to transform one-side, tabulator-imprinted forms into postcards so that the necessary data are printed on both sides. The resulting mailing bill meets all post office regulations.

In operation, the unit receives connected forms on which all imprinted information appears on one side. The continuous form is fed over an angled turn bar and folded on a center perforation. It then passes through a heat-sealing unit where heated plates perform a permanent sealing action. Automatic controls prevent scorching and spoiling of forms. The sealed forms are then fed through a tab card burster where they are separated into individual postcards ready for mailing. Setup allows use of forms produced in only one pass through a printer or tabulator. System operates on 110 v, 60 cycles, with separate switches for all electrical components. **Standard Register Co.**, Dayton, Ohio.

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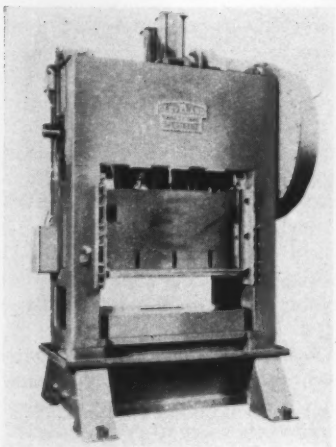


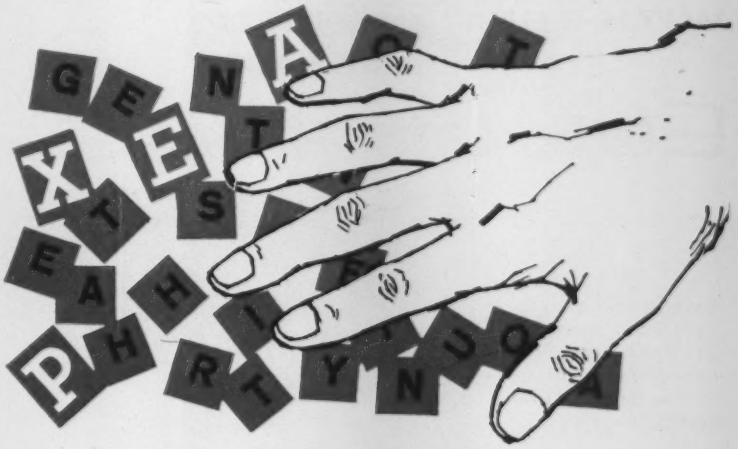
Double Eccentric Press

Item 409

Double eccentric press has a capacity of 200 tons, will operate at a speed of 50 to 150 strokes per minute. Bed area is 36 by 54 inches with a 4-inch stroke of slide with a 2-inch adjustment. By modifying various dimensions such as stroke, slide adjustment, bed and slide areas, the press can perform punching, shearing, perforating, bending, and forming operations.

Feature of the press is the four piece tie-rod construction. The slide has power adjustment and is air-counterbalanced. The drum type friction clutch is electrically controlled and has a spring-loaded brake. The eccentric shaft is extended at the side of the crown to

Your product isn't complete...



...until all the components...

APEX
THE AUTHORITY ON FASTENING

...are properly assembled!

Assembly is one of the most important of all production operations. An efficient, economical assembly operation can depend upon your choice of the right fasteners and the right fastening tools.

Once you've selected the types of fasteners best fitted to your applications, you can select the correct fastening tools from the complete Apex line. For most applications, simply make your choice from the thousands of Apex standard or magnetic nut running and screwdriving tools available from stock. For special applications, just ask Apex—the authority on fastening—for practical assistance in solving your problems.

Write, on your company letterhead please, for

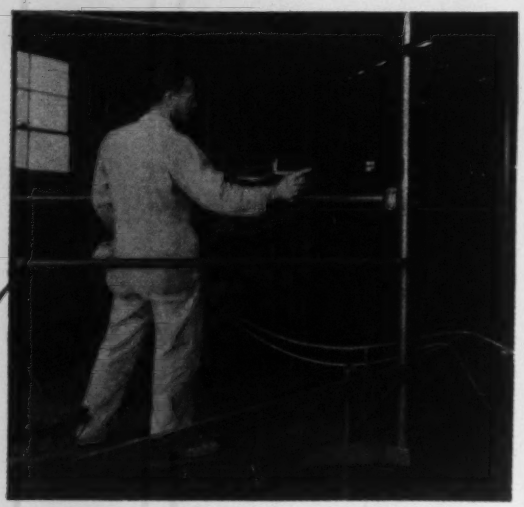
CATALOG 30-A—Nut Running Tools (up to 5/8" sq. dr.)
CATALOG 30-B—Nut Running Tools (3/4" to 3 1/2" sq. dr.)
CATALOG 30-C—Screwdriving Tools
CATALOG 30-D—Miscellaneous Fastening Tools

APEX FASTENING TOOLS
SCREWDRIVING • NUT RUNNING • SPECIAL

Circle 688 on Page 19

FASTER . . . CLEANER . . . MORE ECONOMICAL WHEN YOU PAINT WITH THE RANSBURG

Electrostatic Hand Gun



Gator Boat transport trailers are painted in less than half the time—with half the paint—with the new Ransburg Electrostatic Hand Gun.

For instance

Peterson Bros., Inc., Jacksonville, Florida and Ft. Wayne, Indiana, world's largest manufacturer of boat trailers for the Marine Industry, switched from air hand spray to Ransburg No. 2 Process Electrostatic Hand Gun at the Fort Wayne operation in the finishing of their big custom line boat trailers and their Gator line of Marine Trades Equipment.

Paint saving with the Ransburg Hand Gun is estimated at 50 to 60% over the former method. Construction of their products (they use a lot of tubular steel) is ideal for Hand Gun application because of the "wrap-around" characteristic of Electro-Spray.

Painting is done now in an open spray room where two water-wash booths stand idle. Not needed! Maintenance in the paint room has been reduced 75%, for where they used to have to clean up the room sometimes twice a week (mostly on overtime) it now goes two or three weeks without cleanup.

One of Peterson's biggest products now painted electrostatically is a boat transport trailer, Model 807, built to haul six 16-ft. runabout boats. The trailers are over 31-feet long; overall height is 11'-2" and almost 8' wide. With air spray, it used to take 8 hours, or more, to paint the big vehicles. Now, with Ransburg No. 2 Process Electrostatic Hand Gun, one operator does the job in only 3½ hours. And, with half the paint!

NO REASON WHY YOU CAN'T DO IT, TOO!

Write for information and literature about this revolutionary, new painting tool. See how the Electrostatic Hand Gun can save time . . . paint . . . and cut costs in YOUR finishing department. If your production justifies conveyorized painting, it'll pay you to investigate Ransburg's automatic electrostatic spray painting equipment. Write for our No. 2 Process brochure which shows numerous examples of modern production painting in both large and small plants.

RANSBURG

RANSBURG
Electro-Coating Corp.
Box-23122, Indianapolis 23, Indiana

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provide for driving a feed mechanism. **Cleveland Punch & Shear Works Co.**, 3917 St. Clair Ave., Cleveland 14, Ohio.

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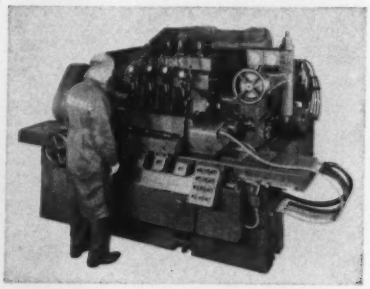

Multiple Wheel Grinder

Item 410

Available for automatic or semi-automatic operation, multiple wheel precision cylindrical grinder will grind two or more concentric diameters to close tolerances on a production basis. Parts such as crankshaft and camshaft line bearings, transmission shafts, and components of jet engines can be accommodated on the machine. Unit is made in 10 and 14-inch swings with 30-inch length between centers. The wheel diameter for the 10-inch swing is 36 inches—for the 14-inch swing, wheel diameter is either 36 or 42 inches.

Feature of the grinder is a wheel feed system designated Microfeed. It will feed the grinding wheels in increments as small as 50 millionths of an inch. The feed automatically compensates for all variables caused by deflections of machine parts from grinding forces, variations due to minor temperature changes, changes in wheel characteristics due to grinding and dressing, and variations in feed rates due to temperature changes of hydraulic oil. Corrective action is applied continuously.

The grinding wheels are dressed with individual diamond dressers mounted on the sliding table at the front of the machine. This method assures dressing the wheel faces parallel to the work center line. It also eliminates taper which sometimes develops from temperature changes of the grinding wheel head and spindle bearings. **Landis Tool Co.**, Waynesboro, Pa.

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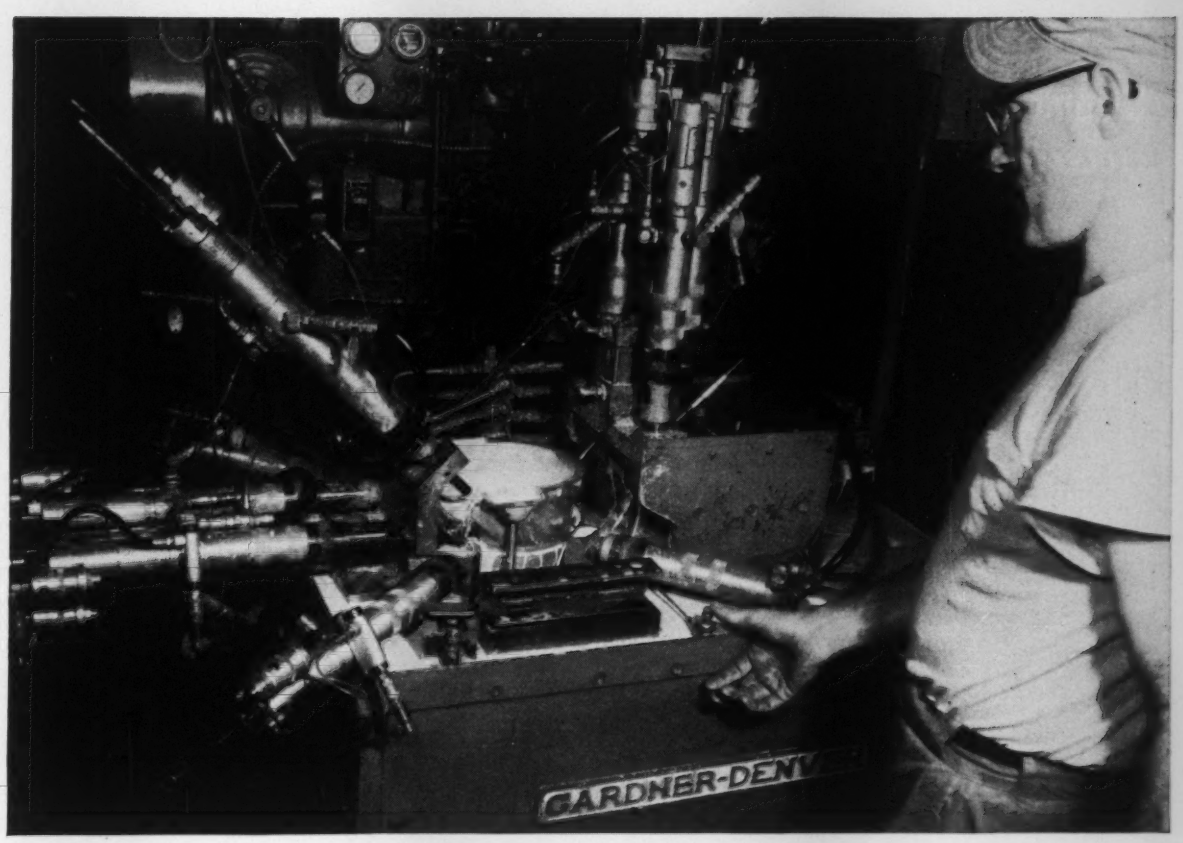


Time study clocks multiple drilling operation at 254 pieces per hour

15 HOLES DRILLED IN VACUUM CLEANER MOTOR BASE IN LESS THAN 15 SECONDS

Problem: To speed drilling of fifteen .120″-diameter holes in the motor base of a vacuum cleaner at Eureka-Williams Corporation plant in Bloomington, Illinois.

Solution: A specially designed Gardner-Denver multiple drilling machine. Ten drills, standard Model 92-2P "Airfeedrills"®, are permanently mounted on the fixture. Five "Airfeedrills" are vertically mounted on a reciprocating slide to facilitate loading and unloading the part.

How it works: Operator places the part in the fixture, then activates the following cycle: Two air clamps automatically hold the part in position. Then ten drills automatically start drilling, as the reciprocating slide moves into position and drills the remaining five holes. The operator then presses a release button which returns the reciprocating slide and deactivates the air clamps, leaving the part free for removal.

Cost-cutting results: A recent time study clocked this unique drilling operation at 254 pieces per hour—or a part processed in approximately *15 seconds*. This is a typical example of special machines designed and built by Gardner-Denver to solve tough production problems. For complete information, contact your Gardner-Denver representative.

GARDNER-DENVER Since 1859 100 1959 YEARS

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

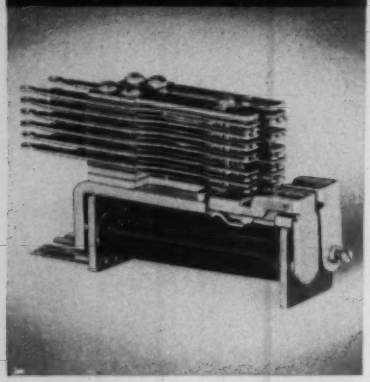
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Circle 690 on Page 19

Stromberg-Carlson

"TELEPHONE QUALITY"

Relays



. . . available immediately for any part of your operation that depends on electromechanical switching.

Proven by many years of meeting the exacting requirements of the telephone industry, these twin-contact relays of unsurpassed reliability are available in many types. The following are representative:

Type A: general-purpose relay with up to 20 Form "A" spring combinations. This relay is excellent for switching operations.

Type B: a gang-type relay with up to 60 Form "A" spring combinations. **Type BB** relay accommodates up to 100 Form "A" springs.

Type C (illustrated): two relays on the same frame. A "must" where space is at a premium.

Type E: has the characteristics of Type A relay, plus universal mounting arrangement. Interchangeable with many other makes.

Complete details and specifications on all Stromberg-Carlson relays are contained in our *new relay catalog*. Contents include: spring combinations, table of equivalents, contact data, variations and special features, plus complete mounting and cover information.

The catalog is available on request.

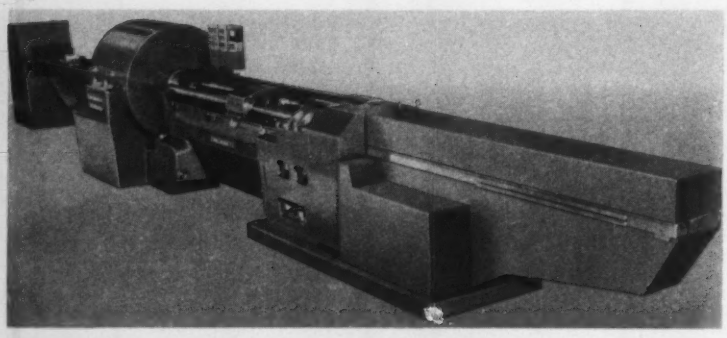
STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

Telecommunication Industrial Sales
111 Carlson Rd. • Rochester 3, N.Y.

S-C

Circle 691 on Page 19

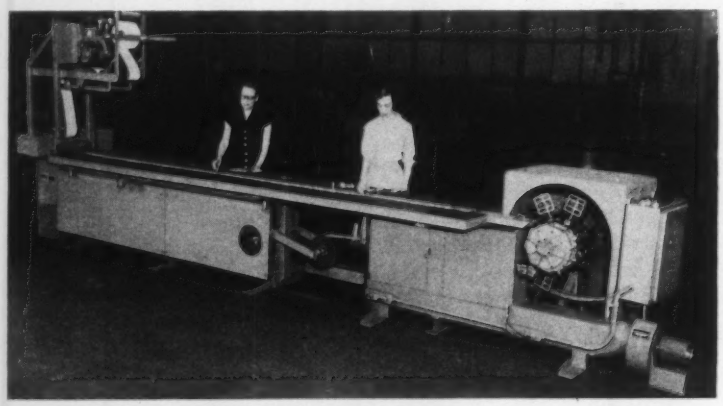


Pulsating Die Cold Forming Machine

Item 411

Equipment is capable of cold forming cylindrical workpieces such as tubes or rings to obtain profiles on their inside diameters. The method of forming is attained with a mandrel inserted in the work prior to its being squeezed by rapidly pulsating dies. At the completion of the operation, the profile of the mandrel has been reproduced in the ID of the part. Four forming dies pulsate rapidly while revolving around the OD of the work. The dies, mounted on cams, are caused to pulsate through contact with a series of free-wheeling, hardened steel rollers located in a raceway in the machine's headstock. Each cam passes from one roller to the next to produce the pulsating action of the die. The top surface of the cam has the form of a sine curve and does not lose contact with the rollers. This results in a smooth, continuous squeezing action on the part of the dies—noise and vibration are held to a minimum even though the workpiece is being squeezed by the dies more than 1000 times per minute. Known as Intraform, machine forms nonferrous and ferrous alloy workpieces ranging from $\frac{1}{8}$ to 5 inches in diameter. Workpieces can be premachined blanks, tubing, castings, forgings, extrusions, or produced by the powdered metallurgy process. In addition to forming profiles in either open or blind holes, unit can bond two or more metals (seamless steel tubing with a brass lining, or aluminum electrical conduit tubing with a lining of copper). **Meta-Dynamics Div., Cincinnati Milling Machine Co.**, Cincinnati 9, Ohio.

Circle 411 on Page 19



Thermoform Packaging Machine

Item 412

Unit can produce thermoformed blister or bubble packages in a wide range of sizes and shapes. Packages measuring 4 by 4 inches are formed at the rate of 60 per minute. The vacuum-formed packages become their own conveyor as they move through the machine. A

flange base produced during the forming operation is used to support the package and parts as both ride on guide rails of a loading table during the packaging operation. An adjustable handwheel calibrated for width settings permits a broad range of package widths. Table lengths depend on the product or product package.

In operation, film material comes from a roll of plastic mounted in the machine base. It is drawn through a series of heat lamps before passing between a roll and drum located at the entry end of the machine (at right in illustration). Here it is heated to approximately 300 F, clamped in a station on the revolving drum, and drawn to shape. This function is performed by vacuum being applied to draw the thermoplastic material into the mold or form. As the drum continues to revolve, clamps are automatically opened and the strip is released to continue through the machine. Parts are next placed into each formed bubble by operators or automatic loaders. To seal the packages, heat sealable paper or plastic is withdrawn from an overhead roll and applied by sealing rolls. The sheet used may be imprinted with trademark and product information as it is withdrawn. Packages coming off the line can be cut off individually or into predetermined multiples by means of a counter, or they can be run in a continuous ribbon. **Sundstrand-American Broach. Div., Sundstrand Machine Tool Co.**, Ann Arbor, Mich.

Circle 412 on Page 19

Data Logging System

Item 413

System is designed for applications where centralized data transmitting and logging systems are required, such as in the pipeline and petroleum industries, electric utilities, and commercial buildings. The instrument converts analog - type quantities to a binary code form and transmits the information from a remote location. When received at a master station, the code is converted to decimal form for visual display or logging using an electric typewriter. System, designated

Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66a.

DUFF-NORTON COMPANY

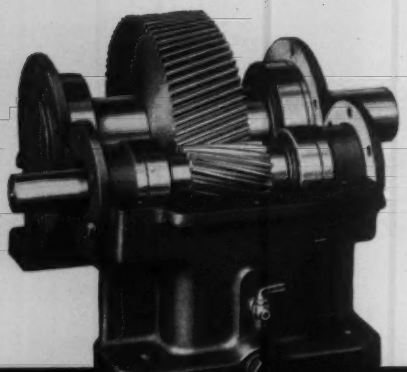
P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet • Screw
Hydraulic • Worm Gear

COFFING HOISTS
Ratchet Lever • Air
Hand Chain • Electric

Circle 692 on Page 19



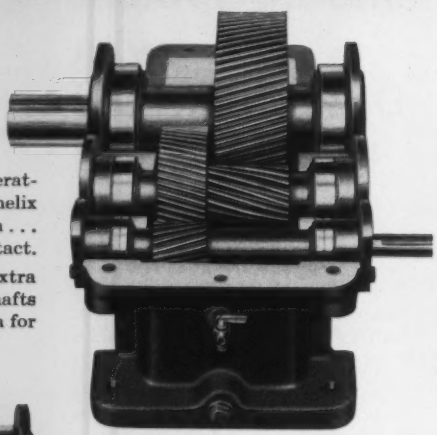
Eliminate Your Down Time Worries . . .

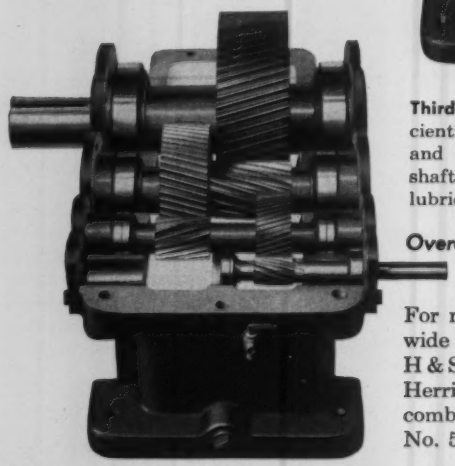
Specify **H & S**
Helical Speed Reducers
Single · Double · Triple Reduction

Extra rugged construction, simplicity of design are your assurance of consistent day-in-day-out trouble-free operation and exceptionally long service life. Here's why:

First—The helical gears are generated by H & S at the most efficient helix angle to insure smooth operation . . . several teeth are always in contact.

Second—Heavy-duty housings, extra bearing capacity and oversize shafts guarantee ample reserve stamina for the most exacting demands.



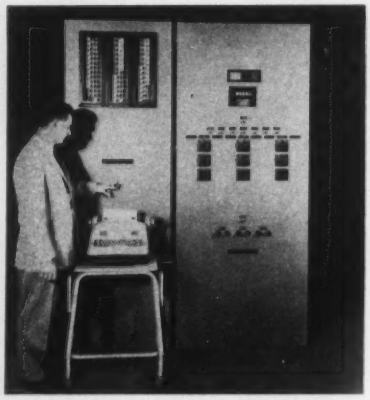


Third—Bearings and gears are efficiently splash lubricated, and dust and oil-proof seals on extending shafts keep out trouble—keep in lubricant.

Overall design conforms to AGMA specifications

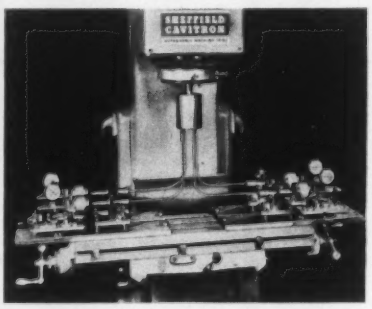
For more detailed specifications, wide size and capacity range of H & S Speed Reducers (Helical, Herringbone, Worm Gear and combinations) write for Catalog No. 55.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
5112 Hamilton Avenue • Cleveland 14, Ohio



APRIL (Automatically Programmed Remote Indication Logging), can be incorporated as part of a new supervisory system or added to existing GE equipment. It can be used on its own channel or on a supervisory channel. **Medium Voltage Switchgear Dept., General Electric Co.,** Schenectady 5, N. Y.

Circle 413 on Page 19



Ultrasonic Workhead

Item 414

Extension-type tooling unit transmits high-frequency mechanical oscillations from a single transducer to multiple machining heads by means of curved cylindrical rods. Machining heads may be at any angle with respect to the transducer. There is one rod for each head. In the application shown, four machining stations are mounted on the table of a standard machine. This permits up to four different precision operations to be conducted on four different workpieces simultaneously. Identical workpieces can also be advanced progressively through each station. The stations can be operated simultaneously or independently. Each unit can accommodate a cutting tool up to 1½ inches in diameter and will machine

Circle 693 on Page 19

workpieces up to 2 inches in diameter to a depth of 0.050 inch. Each workpiece station has an independent feeding device; depth of cut is indicated in 0.0001-inch increments. **Sheffield Corp.**, Dayton, Ohio.

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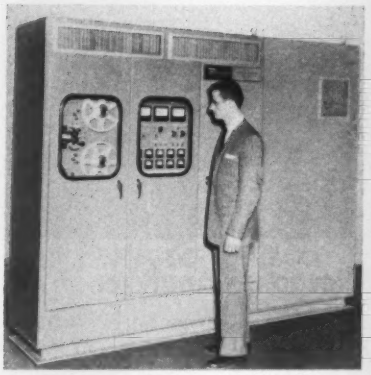


Numerical Control

Item 415

Milling machine control unit provides control of 3 axes (longitudinal, transverse, and vertical); is also capable of being switched from control of a linear motion to that of a rotary table or tiltable spindle. It is suitable for machining shapes such as turbine parts, cams, and aircraft and missile bulkheads. Command pulse values (from 0.0002 to 0.000025-inch) from the control unit to the machine tool can be achieved.

Input to the control unit is punched tape. A high speed tape reader on the machine control unit permits tape reading of 300 lines per second in the forward direction and 600 lines per second in the reverse direction. Feature of the unit is a decimal display position indicator which has a continuous readout of position location of any axis. Another feature is a feed rate override which allows the machine operator to reduce the programmed feed rate down to as little as 20 per cent of the programmed rate. Symmetrical parts can be easily made from the same control tape. A reversing circuit is provided for each axis which reverses the direction of machine motion from that specified on the tape. Four tape control units available will automatically control functions such as coolant

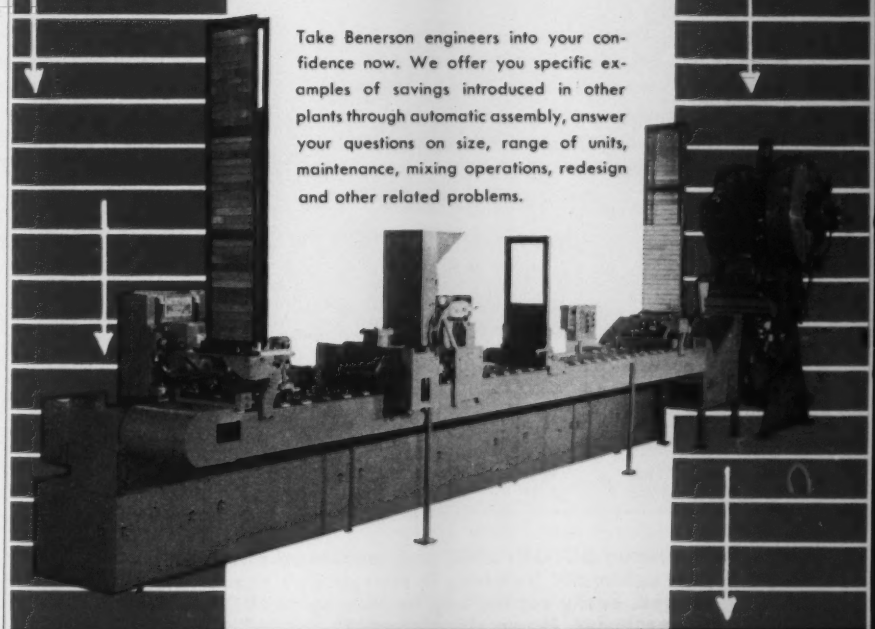
Circle 694 on Page 19→

How Automatic Assembly starts with the BENERSON AUTOMATOR:

Low cost, high-speed automatic assembly of your volume product gets its logical start with the Benerson AUTOMATOR, pre-engineered indexing chassis. Its precision and design flexibility provide the base onto which Benerson engineers the fixtures and devices for machining, riveting, welding, sorting, orienting, feeding and inspection.

By consulting Benerson at the outset of your interest in automatic assembly, you gain the proven advantages of Benerson experience in developing high-production machines that lower unit costs, improve quality and reduce scrap.

Take Benerson engineers into your confidence now. We offer you specific examples of savings introduced in other plants through automatic assembly, answer your questions on size, range of units, maintenance, mixing operations, redesign and other related problems.



PHONE, WIRE OR WRITE TODAY!

BENERSON

CORPORATION

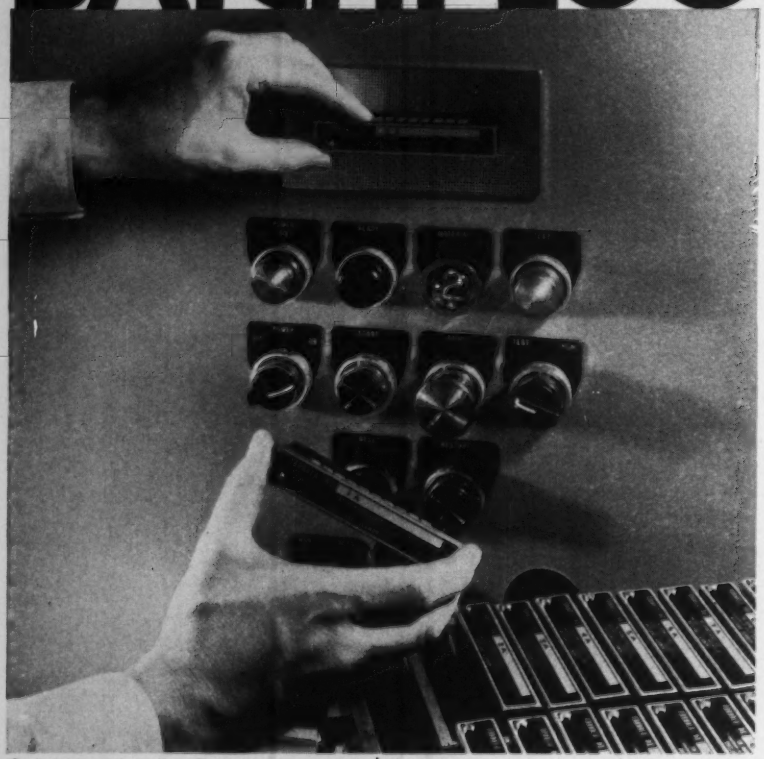
1319 WEST FLORIDA STREET, EVANSVILLE 10, INDIANA

"First Name in Automatic Assembly"

REPRESENTATIVES: Machine Tool Sales, Avon, Conn.; Don Leslie & Co., Wayne, Pa.; Arthur N. Monaco, 5409 W. Madison St., Chicago, Ill.; Price Equipment Co., Monroe, N. C.; Philip Seibert, P. O. Box 9176, Birmingham 13, Ala.; Richard Stahura, 3537 Lee Rd., Shaker Heights, Ohio; C. W. Venables Co., 24634 Five Mile Rd., Detroit 39, Mich.

NEW LOW COST AUTOMATIC BATCHING
WITH INSTANT FORMULA CHANGING

HOWE
BATCHPLUG

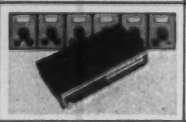


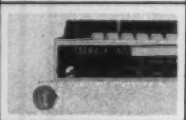
1 Quickly and easily adjusted to accurate settings.

2 Each standard Batchplug controls up to 10 ingredients, 3 scales.

3 Sealed for privacy—no dials to reset—no operator error.

4 Inserting Batchplug changes entire plant to new formula instantly.





The Howe BATCHPLUG* cuts panel and circuit costs—puts automatic batching in everybody's reach! Simple, rugged, easily set for any formula up to 10 ingredients. An exclusive Howe development! **Pat. Pending*

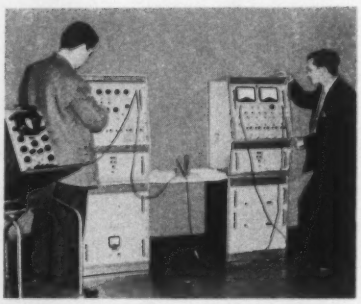
HOWE

THE HOWE SCALE CO. • RUTLAND, VT.
A SUBSIDIARY OF SAFETY INDUSTRIES, INC.

WRITE TODAY FOR OFFICE DEMONSTRATION OR NEW BATCHPLUG FOLDER

flow, spindle speed, tool changes, table indexing, and chip conveyor. **Industrial Controls Section, Bendix Aviation Corp.,** 21820 Wyoming Ave., Detroit 37, Mich.

Circle 415 on Page 19



Response Analyzer

Item 416

Process response analyzer (Model JY 743) is a precision electronic instrument capable of measuring system transfer functions in the frequency range of 1 cycle in 10,000 seconds to 100 cps. It is suitable for use in the automatic control of fluid, thermal, and chemical processes, on numerous types of large hydraulic and electrical servos, or on any continuous control system having dynamic lags within the frequency range of the instrument. Other applications are: measurement of open and closed loop responses to investigate stability and bandwidth or to aid reshaping the response to obtain compatibility between these two requirements; evaluation of the dynamic characteristics of particular loops of a complex multiloop system and transfer functions of specific paths within these loops.

Equipment includes a low-frequency oscillator which provides a sinusoidal forcing function, and a resolved - components indicator which accepts the output from the system under test, operates mathematically on it and presents the results. The oscillator is an analog computer second order loop comprising two integrators and a sign-reversing stage, the frequency being varied by altering the loop gain. Using two further sign-reversing units, a four-phase output is made available. The final reading is automatically displayed in the form of completely static meter readings equal to the *in-phase* and *quadra-*

ture components of the fundamental frequency. Oscillator *Prime, Start,* and *Hold* conditions may be controlled directly or by an external analog computer. **Solartron Inc.,** 530/532 Cooper St., Camden 2, N. J.

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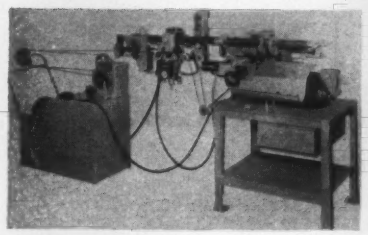

Wire Prefeeder Unit

Item 417

Self-adjusting, auxiliary prefeeder unit feeds insulated wire from a reel to a company measuring, cutoff, and stripping machine. The rate of feed from the wire reel in the prefeeder is automatically regulated to keep pace with the operating speed of the machine. This is accomplished by means of a linkage between a floating lever arm and a variable-speed sheave mounted on a pivoted bellcrank. When machine operation increases the tension in wire being fed, the lever arm is pulled over and the sheave adjusted, giving proportional speed to the pressure roll drive which pulls wire from the reel.

Heavy reels of wire can be mounted on a shaft or can be supported on a three-roller system in the cradle. Illustration shows the wire reel mounted on a shaft. After the wire has been threaded through four pulleys of the prefeeder unit and into the machine, there is no further setting or adjustment required. When the stripper machine is not operating, there is no tension in the feedout wire from the prefeeder unit. As soon as the machine starts operating, only slight tension in the feedout wire will move the lever arm. Initial lever movement then automatically releases a limit switch to start the motor-driven power train. This rotates the pressure roll and pulls wire from the reel for feeding. **Artos Engineering Co.,** 2757 S. 28th St., Milwaukee 46, Wis.

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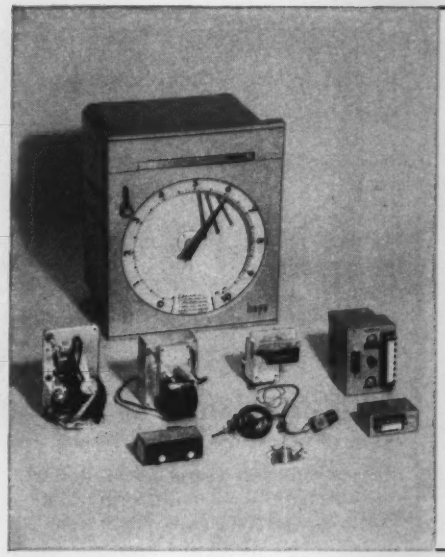


- *Provides continuous record of four variables on one chart; plus, in many cases, an additional integrator, pneumatic controller or transmitter.*
- *Accepts either linear or non-linear signals and records all four records on a linear chart.*
- *Provides record of flow, % O_2, % H_2 liquid level, pressure, temperature, position, pH, integration, many others.*

FROM **HAYS**—

A truly Universal Recorder

With the new Hays Universal Recorder you get a flexibility unknown in previous instruments. Now, through use of this one 4-pen recorder measuring only 16″ x 19½″, shown above with its standard components, you can develop an almost infinite number of recorder combinations.

The secrets of the flexibility of the Hays Universal Recorder are "quadrant construction" and the basic receiving units developed for incorporation into the recorder. For example, the **two new electronic receivers:**

1. A differential transformer type receiver used in conjunction with Hays standard transmitters for pressure, temperature, flow, liquid level, or other customer specified input motion.
2. A slide wire electronic type receiver used in A-C resistance bridge measurement and D-C potentiometer circuitry for measurement of oxygen, % CO_2, % Hydrogen, pH, resistance bulb, and potentiometer applications.

Both electronic receiver units utilize a cam which allows them to correct for non-linearity of input signals. This means that the chart can be used to accommodate 4 non-linear input signals on a linear chart.

Direct receiver units, shown above, are also provided for pressure, temperature, and pneumatic signals. Two of these units may be mounted in one quadrant.

An integrater or a pneumatic transmitter or controller may also be mounted in one quadrant of the instrument. Therefore, in applications involving direct receivers, it is possible for this one instrument to provide four continuous records plus integration, or four continuous records plus a pneumatic transmitter or controller.

Inputs acceptable are: A-C resistance bridge and battery less D-C potentiometer, high and low impedance applications with ± 0.25% accuracy.

The uses of this new recorder in solving your instrumentation problems are limited only by your own ingenuity . . . this advertisement can only begin to suggest possible applications. *For further information on this versatile new instrument write for Bulletin 58-B771.*

THE hays CORPORATION

MICHIGAN CITY 55, INDIANA

Circle 696 on Page 19

NEW
DIXON AUTO-TORQUE *Driver*

SCREWS AND NUTS AUTOMATICALLY DRIVEN WITH PRECISE TORQUE CONTROL

Gives you . . .

1 **Complete control of screws from parts feeder to chuck, until threads are started. No dependence on gravity to load chuck.**

2 **Exclusive built-in sensing, assures that screw is driven. Automatically retracts driver only after attaining proper torque.**

3 **Complete automatic cycle, requires only a touch of the pedal.**

4 **Torque accuracy within 5%, comparable to most precise hand-torquing methods.**

5 **Clutch free-wheels after driving. Operator cannot vary the torque.**

6 **Two ranges of torque available 0 to 84 inch-pounds and 48 to 120.**

7 **Work height adjustment with 14" range, can be made without in any way disturbing the machine adjustments.**

Model SD-100, above, tooled for any standard screw up to 5/16" thread size. Special tooled feeders available. Model SD-101, without floor column, provides a complete automatic station. Maximum width 6 inches.

The new DIXON *Auto-Torque Driver* includes all the features of the DIXON Auto-Positioner, and has an efficient space-saving air motor with an adjustable-torque clutch. These features provide for *positive* handling, giving new efficiency in driving screws and nuts.

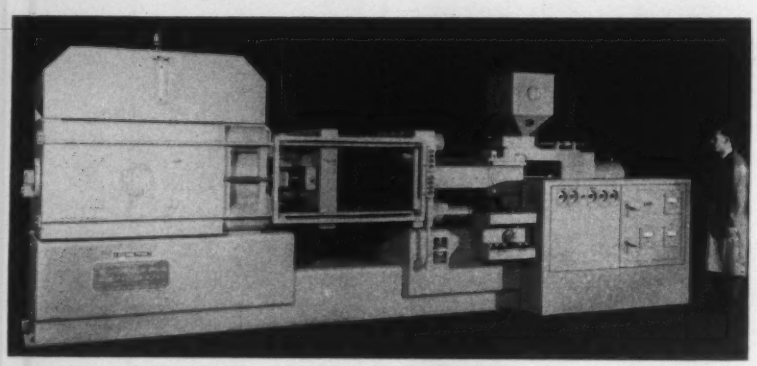
ASK FOR BULLETIN SD-B1 illustrating and describing design and operating features and giving specifications.

DIXON AUTOMATIC TOOL, INC.

DIXON **2312 - 23rd AVENUE ROCKFORD, ILLINOIS**

Equipment for Automatic Parts Handling and Assembly

Circle 697 on Page 19



Plastics Injection Molding Machine

Item 418

Injection molding machine has a full hydraulic clamp with 22-inch stroke and 34-inch daylight opening (42-inch daylight opening with ejector box removed). The clamp of Model 350-HV (a 350-ton unit) automatically adjusts for different mold thicknesses. At full clamp stroke with maximum tonnage, 600 cycles per hour are possible and as many as 1000 cycles per hour reduced stroke. Any part of the total ram stroke can be used. Clamp controls are centralized and limit switches provide adjustment for stroke, daylight opening, slow-close for die contact, slow break-away, and ejection stroke.

The injection circuit features controls for prepacking; flow control for plunger slow-down, dual pressure adjustment for lower holding pressure after the mold is filled, and automatic unloading of the injection pump. A differential circuit provides rapid prepositioning of the injection plunger. A separate pilot circuit has external pressure and pilot lines to each individual valve. This feature is said to insure uniform shift of valves.

An overhead oil tank incorporates oil bath air cleaner, oil level gage, and thermometer. Hydraulic oil is located over the pumps and main cylinder which results in positive gravity prefill action. Electrical control panel houses the main electrical controls such as the motor starter, pyrometers, timers, relays, and transformers. The only electrical hook-up required to put the machine in operation is to bring main power to the panel. **Hydraulic Press Mfg. Co., Div., Koehring Co.**, Mount Gilead, Ohio.

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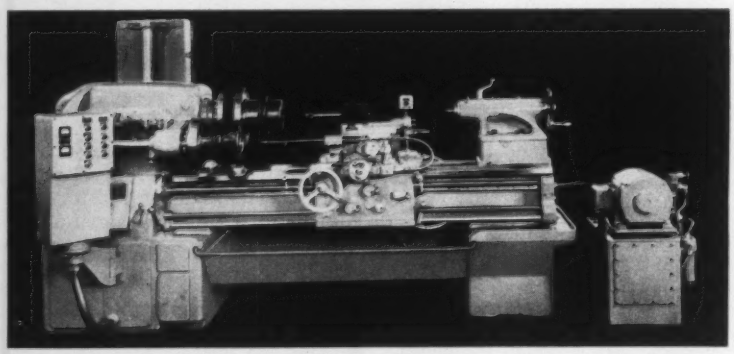


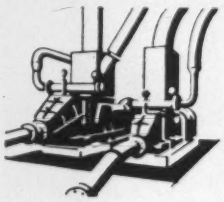
Rotary Profile Tracer Lathe

Item 419

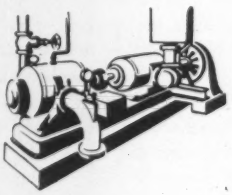
Designed for boring bottle molds which have noncircular cross sections, lathe is also suitable for conventional turning, boring, and threading operations. Feature of the unit is an electrohydraulic tracer. The head of the tracer is built into a bar that is adjustably mounted at the front of the cross slide. Stylus deflection pressure is 1½ ounces. At a feed of 100 inches

FULLER EQUIPMENT

for the process industries

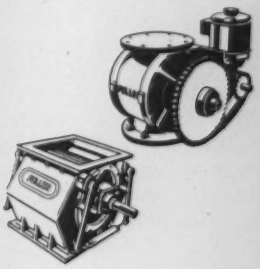


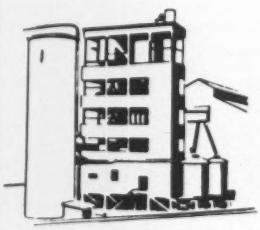
Pneumatic Materials Handling Systems. Widely specified throughout the process industries, Fuller's range of equipment offers best single source for solving problems in moving dry bulk materials pneumatically. Fuller-Kinyon Pumping Systems, Airveyor® Pressure and Vacuum Conveying Systems, and F-H Airslide® Fluidizing Conveyors are completely sealed to prevent both contamination of the product and any leakage of dust, etc., into the surrounding area. They are used to move dry, granular and pulverized materials to and from cars, ships, trailers, storage and processing points.



Fuller Rotary Compressors and Vacuum Pumps are vibration-free, can be installed anywhere, even on balconies. Fewer moving parts mean minimum maintenance. Compressors and Vacuum Pumps handle air and gases from 30 to 3300 cfm at pressures to 125 lb. gage. Vacuums to 29.95 in. (referred to 30-in. barometer).

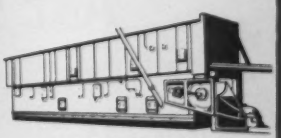
Fuller Vane-type and Roll Feeders . . . for volumetrically controlled feeding of a wide range of dry pulverized or granular materials. Also Fuller Rotary Valves . . . used under silo deck slabs and bins to permit the free flow of pulverized materials which tend to arch, such as lime and cement raw materials.





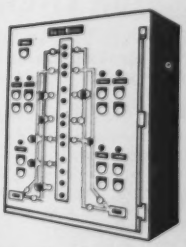
Fuller Preheaters, Humboldt Suspension Type . . . for preheating dry, pulverized Portland cement raw materials with rotary kiln waste gases.

Fuller Horizontal and Inclined Grate Coolers are compact, easily installed for fast, efficient cooling of materials such as nodulized phosphate rock, pebble lime, ores, dolomite, iron nodules and Portland cement clinker from 2800°F. or higher to any desired point within a reasonable range of atmospheric temperature.



Fuller-Material-Level Indicators signal audibly and visibly when materials reach a predetermined high or low level. Controls conveyor motors, valve circuits, etc.

Fuller Control Panels permit automatic, remote, one-man control of multiple operations. Easily-read panel permits visualizing flow of material to storage or from process bins.



Fuller equipment is designed to help give you maximum efficiency at minimum cost. Send today for more detailed literature.

1356
G-210

FULLER COMPANY GENERAL AMERICAN TRADE MARK

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162 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
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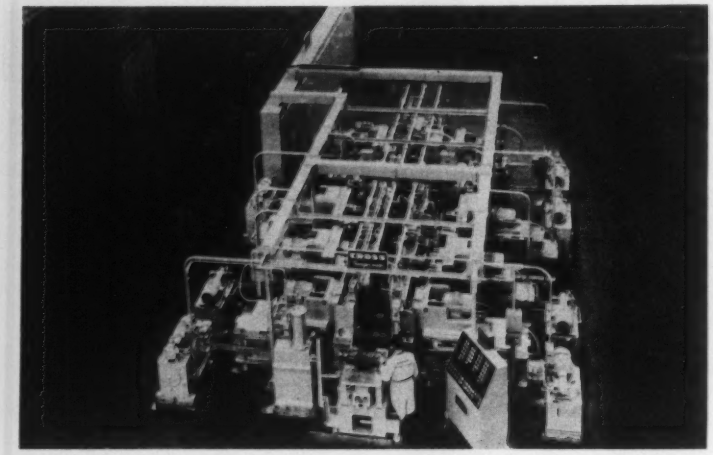
Fuller
. . . . pioneers in harnessing AIR

Circle 698 on Page 19

per minute, accuracy of duplication of the tracer slide is ±0.001-inch. Maximum tracer slide stroke at one setting is 4 inches. Tool adjustment for diameter is by means of a slide mounted between the tracer slide and a swiveling tool slide. The swiveling tool slide is set parallel to the work axis for length adjustment of the tool. The cross slide has automatic pressure lubrication. For convenience of setup and operation the master spindle is located at the front of the machine.

A positive gear drive can be adjusted to remove all backlash between the lathe spindle and the master. It is located from the headstock spindle through a quadrant mounted idler. A timing device on the master spindle provides for angularly positioning the master mold and workpiece. With the master spindle locked stationary (either a female or a male master can be used), a half-mold or a conventional flat template can be used to guide the tool for boring or turning. **Monarch Machine Tool Co.**, Sidney, Ohio.

Circle 419 on Page 19



Equipment Processes Cylinder Heads

Item 420

Sixteen-station unit is capable of machining the ends of 2, 3, and 4-cylinder cast iron heads for two-cycle, in-line Diesel engines. Heads being processed range in length from 12 inches on the 2-cylinder head to 24 inches on the 4-cylinder head. The output ranges from 38 to 44 heads per hour, depending on the head size being processed and the method employed for deep hole drilling at several stations. In addition to face milling water outlet pads and oil and fuel hole bosses on three planes, the machine also drills, chamfers, and taps all oil, fuel, and screw holes and air tests the part for casting density.

The machine setup for processing a cylinder head requires mounting of the proper fixtures and machine units for the particular head. This is accomplished by tie rods that connect the fixture to the machine unit. The machine unit is then advanced or withdrawn to position the fixtures to accommodate the head being processed. When in position, dowel pins inserted manually into locating holes on each side of the fixture base locate the fixture on its own hardened and ground ways. Features of the transfer unit include: An integral chip disposal system, a central coolant and filtration system, "woodpecker" drilling mechanisms, and change gears in milling, drilling, and tapping heads for increasing cutting speeds. **Cross Co.**, 17801 Fourteen Mile Rd., Detroit 5, (Fraser) Mich.

Circle 420 on Page 19

all overhead trolley conveying systems

ARE NOT ALIKE!

SUPERIOR ENGINEERING is the BIG "PLUS" at A-F

GETTING THE BIGGEST saving from the installation of an overhead trolley conveying system takes a lot more engineering "know how" than meets the eye.

BUT—because A-F founded the package conveyor industry back in 1901, A-F offers you that *extra* conveying system engineering "know how" that means *extra operational savings!*

For fully automated and semi-automated applications, A-F also *engineers* control centers, positioning devices, automatic loading and discharge units, other ancillary equipment.

Whatever your parts and product handling needs, A-F *engineers* the *right type* of conveying system to cut costs and increase profits in your plant.

Write—without obligation—today!

YOU CAN SEE
THE SUPERIORITY
OF A-F CONVEYOR ENGINEERING

A-F

A-F *ENGINEERED* CONVEYING SYSTEMS

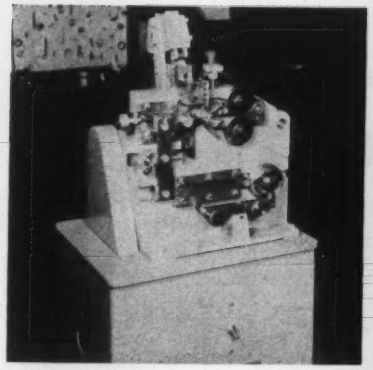
Also Pre-Engineered Conveyors—
Wheel, Trolley, Roller, Belt
Metal Cleaning and Processing Machines

THE ALVEY-FERGUSON CO., 173 Disney St., CINCINNATI 9, OHIO

Automatic Spring Coiler

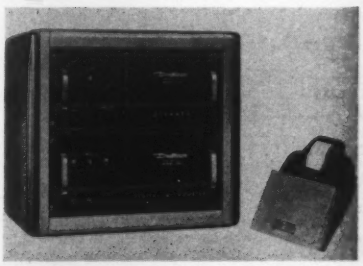
Item 421

Unit can produce a wide variety of springs with round wire without special equipment or arbors. It is adaptable to the speed of assembly line production. There is no limit on length of wire that can be handled. Adjustments for pitch, diameter, and length of spring are



made on the face of the machine. Coiler can handle wire ranging in size from 0.005 to 0.040 inch in diameter. Coil diameter is 0.045-inch minimum ID to 1¼-inch OD. Unit is constructed in a one-piece solid cast frame; has automatic controls; and a ¾ hp, 110 v, 60 cycle, single-phase motor. Variable coiling speed is 40 to 280 inches per minute. With a four-lead worm gear, coiling speed range is increased to 160 to 1120 inches per minute. **Special Machinery Div., Perkins Machine & Gear Co.**, West Springfield, Mass.

Circle 421 on Page 19



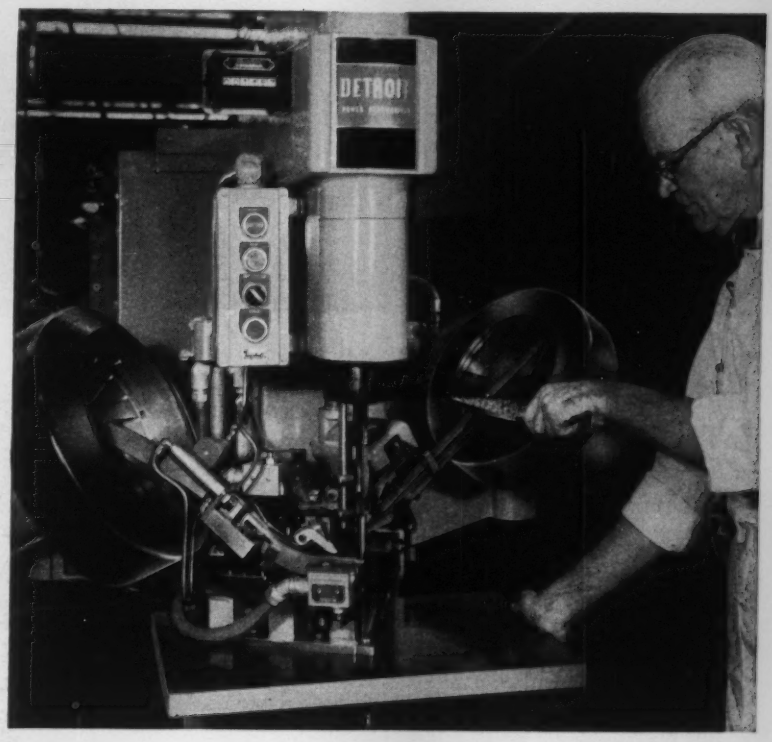
Scanner & Printer

Item 422

Digital unit can measure signals from one to 99 gaging devices in rapid sequence with the identification number and dimension of each point printed automatically on paper tape or stringed cards. Accuracy is 0.0001-inch. Operation of Model 700 can be manual, semiautomatic, or it can be synchronized with manufacturing and inspection processes. Optional output forms include illuminated digital display, input to IBM equipment, and automatic limit detection for alarm or reject. **Daytronic Corp.**, 216 S. Main St., Dayton 2, Ohio.

Circle 422 on Page 19

19,000 ASSEMBLIES...



all in a day's work for DPS special assembly machines

True to its name, Automatic Electric Company has made this small parts assembly *fully automatic* with a DPS assembly machine. A subsidiary of General Telephone & Electronics, Northlake, Ill. the company has realized increased capacity with fewer rejects on telephone terminal assemblies. This type machine in similar assembly operations has paid for itself in less than a year from savings over previous method.

If you have a small parts assembly problem, talk it through with Detroit Power Screwdriver Company. Industry's most advanced design screwdriving machine is the result of more than three decades of specialization. Add to this a complete line of parts feeders (vibratory, rotary and elevating) and you're assured an operation that is automatic and effortless. Write today for full information.

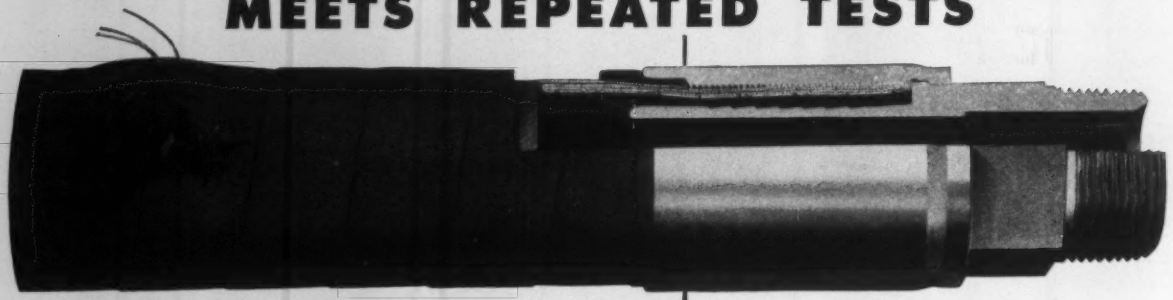
DETROIT POWER SCREWDRIVER COMPANY

2811 W. Fort St. • Detroit 16, Michigan

A Subsidiary of Link-Belt Company

Circle 700 on Page 19

Eastman APPLICATION MEETS REPEATED TESTS



Tests prove that Eastman couplings applied to super high pressure 4-ply spiral wire hose assure successful assemblies. Couplings hold well above minimum burst pressure.

PERMANENTLY ATTACHED COUPLINGS PROVIDE BOND STRONGER THAN HOSE ITSELF!

Increasing demand for greater power brought about the use of higher pressures in hydraulic systems. This not only calls for greater hose strength, but far more critical engineering in coupling design and application.

EASTMAN is contributing toward the development of the trend toward higher pressures—not only in the design and application of coupling to hose—but in the more exhaustive tests required to assure adequate safety under high pressure operations.

The actual photo above is typical of many tests in Eastman laboratories proving that the hose did not fail at the coupling—demonstrating that the coupling was designed and applied to form *a bond which was stronger than the hose itself.*

If you have an application requiring higher pressures, let our engineering department demonstrate the superiority and economy of Eastman applications, and quote on complete Hydraulic Hose Assemblies.

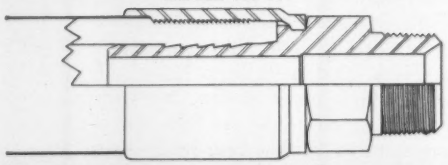
Eastman
first in the field
MANUFACTURING COMPANY
Dept. A-8
MANITOWOC, WISCONSIN

WRITE today for your copies —

Technical Bulletin 100—Medium Pressure Hose and Tube Assemblies, Couplings and Fittings for One Wire Braid Hose.

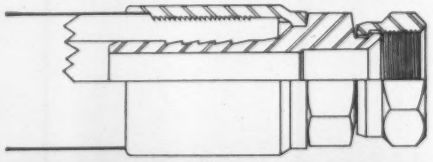
Technical Bulletin 200—High Pressure Hose and Tube Assemblies, Couplings and Fittings for Multiple Wire Braid Hose.

MALE NPTF



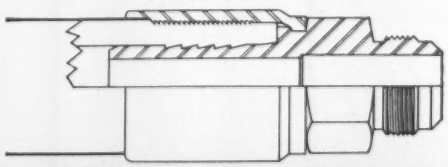
Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12M	¾	1 7/16	19/32	20,000	5,000
8416-16M	1	1 ¾	25/32	16,000	4,000
8420-20M	1 ¼	2	1 5/64	12,000	3,000
8424-24M	1 ½	2 ¼	1 21/64	10,000	2,500

SWIVEL FEMALE JIC-37°



Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12FH	¾	1 7/16	19/32	20,000	5,000
8416-16FH	1	1 ¾	25/32	16,000	4,000
8420-20FH	1 ¼	2	1 5/64	12,000	3,000
8424-24FH	1 ½	2 ¼	1 21/64	10,000	2,500

MALE JIC-37°



Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12MH	¾	1 7/16	19/32	20,000	5,000
8416-16MH	1	1 ¾	25/32	16,000	4,000
8420-20MH	1 ¼	2	1 5/64	12,000	3,000
8424-24MH	1 ½	2 ¼	1 21/64	10,000	2,500

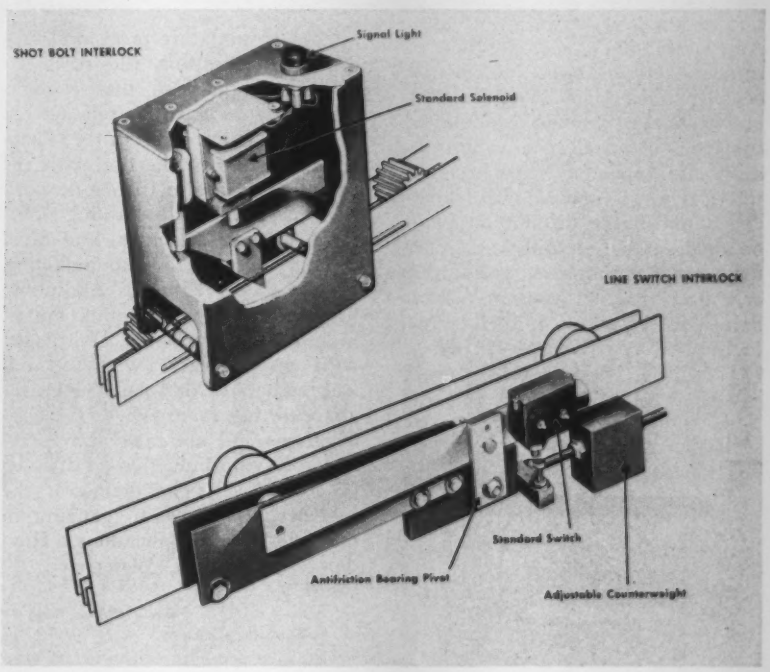
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 19.

Interlocks for Parts Handling Systems

Item 423



TWO accessories for automatic parts handling systems are designed by **F. Jos. Lamb Co.**, 5663 E. Nine Mile Rd., Detroit 34, Mich. The accessories are a line switch interlock and a shot bolt interlock. They are capable of controlling and coordinating chuted parts flow in handling systems and are adaptable to most chute configurations of open design. The line switch interlock indicates parts accumulation at a given point and produces an electrical signal which can be used to control any machine, fixture, or handling function. An adjustable counterweight which actuates the switch can be adjusted for actuation by the weight of one part or the accumulated weight of two or more parts.

The shot bolt interlock permits or prevents part flow and can be automatically operated from a remote pushbutton. With the solenoid or pneumatically operated stop bars arranged to deflect parts into outlet chutes, multiples of the unit can be used to distribute and feed parts to as many as five machines. Both units can be installed in the field and can be relocated in minutes without chute alterations. They are nonjamming and constructed of materials that minimize friction, wear, and part nicking. The line switch and shot bolt do not require tie-ins to machine electrical circuits—an entire system can be operated from a completely independent circuit.

Circle 423 on Page 19

Small size of new short pulse x-ray gage is shown compared to company's previous x-ray unit.

Pulsed Beam X-ray Gage

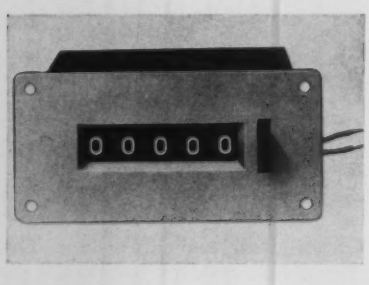
Item 424

Small size x-ray gage incorporates a pulsed beam for thickness measurements ranging from foil thicknesses of 0.00025 inch to plate thicknesses of 1.5 inches. The gage uses a sharply-pulsed, pencil x-ray beam which is *On* for many times a second for only short periods of time. It can measure the thickness of plastics, rubber, paper, fabrics, steel,

copper, brass, and aluminum at speeds up to 6000 fpm.

The gage is comprised of an x-ray generator which supplies a controlled pulsed beam, an x-ray incident unit which detects the amount of transmitted energy, and an indicator console which contains electronic elements to convert and compute the variation of transmitted energy into terms of thickness variations and to initiate corrective action. Features of the gage are: A low noise level, a compensating device for varying material densities, and an absolute thickness calibration constant for the life of the gage. Any errors due to deterioration of components, or beam obstruction caused by gage damage or chips are automatically removed. Some of the types of installation mountings available include: Synchronized travel of source and pick-up for between mill-frame installations, and on rigid, sliding, or rolling C-yokes for manual or motorized positioning or withdrawal. **Daystrom-Weston Sales Div., Daystrom Inc.**, 614 Frelinghuysen Ave., Newark 12, N. J.

Circle 424 on Page 19

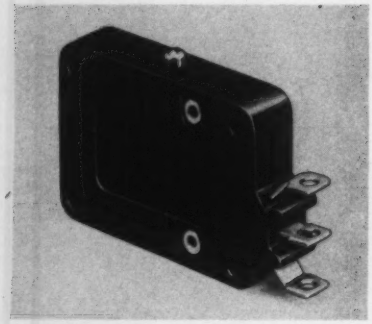


Electric Counter

Item 425

Designed for ac applications, counter can be used with electric computers, card and check sorters, coin counters, electronic scalers and mailing equipment, photoelectric and remote control counting instruments, and production machinery. It can be used with alternating current for both the operating and reset coils. Model YE can obtain speeds up to 1500 counts per minute. It is available in four styles, in either panel or base mounting, with instant electric reset or pushbutton instant reset. **Durant Mfg. Co.**, 1997 N. Buffum St., Milwaukee 1, Wis.

Circle 425 on Page 19

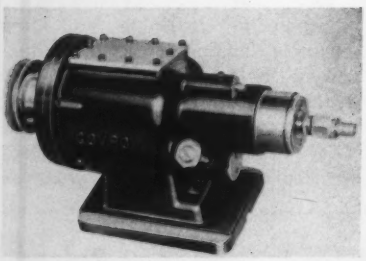


Limit Switch

Item 426

Line of miniature precision snap-acting switches has the terminals molded in place so that contacts cannot move and the relationship between them cannot change. There are 10 models in the line with the actuating button in the center position, covering an operating force range of 3 to 20 ounces and rated 10 amp resistive, 5 amp inductive, at 30 v dc or 115 v ac. Additional 9 styles have the actuating button in an off-center position. Furnished with pin, integral wire, or flat leaf actuators, these models cover an operating force range of 2.5 to 60 grams and are rated 5 amp resistive, 3 amp inductive, at 30 v dc or 115 v ac. The design of the switches is suitable to ganging in multiple circuit applications. **Haydon Switch Inc.**, Waterbury 20, Conn.

Circle 426 on Page 19

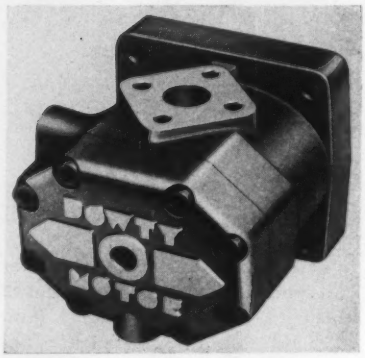


Automatic Drill Unit

Item 427

Model KHB features a built-in feed; does not require shop air. Unit also has an infinitely variable hydraulic rate of feed control, with adjustable rapid approach to control the tool at entry and at breakthrough. The unit will rotate and feed the tool into the work when the motor is turned on and will withdraw when the motor is turned off. Accurate depth is held as the unit dwells against a positive stop at the end of the stroke. To put the unit into operation, it is mounted on a plate and driven by an electric motor through a belt drive. **Govro-Nelson Co.**, 1931 Antoinette Ave., Detroit 8, Mich.

Circle 427 on Page 19

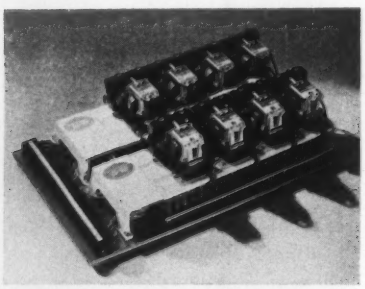


Hydraulic Gear Motor

Item 428

Reversible, hydraulic gear motor has a speed range of 300 to 3000 rpm, with outputs to 25 hp. The cartridge construction eliminates alignment difficulties because the bearings, which also function as endplates and bushings, position the gears within one assembly. The minimum starting torque equals or exceeds 65 per cent of running torque. It will operate on fluids in the viscosity range from SAE 10 to SAE 90. **Berry Hydraulics, Div., Oliver Tyrone Corp.**, Corinth 1, Miss.

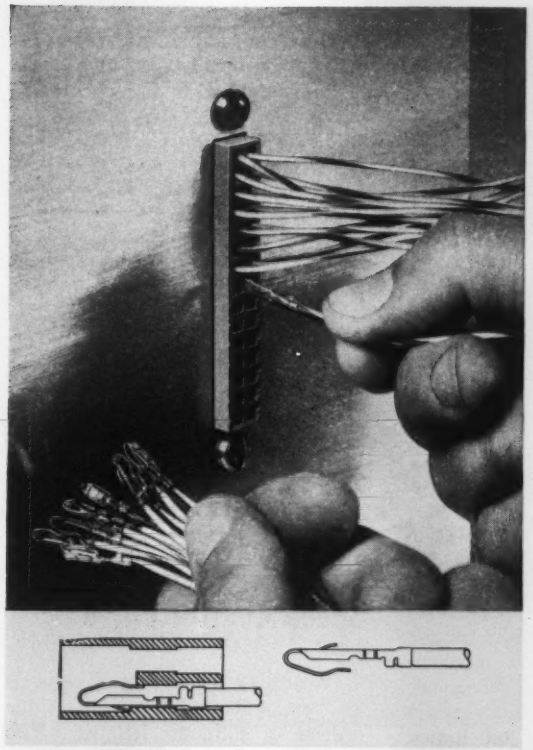
Circle 428 on Page 19

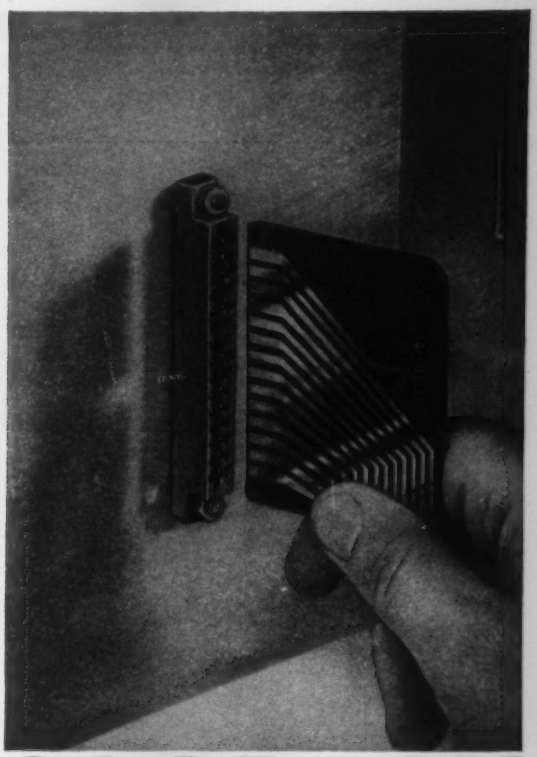


Wiring System

Item 429

Structural wiring system is designed to utilize depth behind relays in control panels. This de-





SNAP IN CLIP IN

THE NEW AMP PRINTED CIRCUIT EDGE CONNECTOR

This A-MP unit is more than new—it is the only *solderless, direct-contact* connector on the market. Designed for both commercial and military requirements, it means faster assembly, greater reliability and versatility to you—at lower cost!

You get construction of unmatched close tolerances in both the contact and the one-piece molded housing. And—because each contact is wholly enclosed within its own housing barriers, there's no need for post insulation. Contacts feature spring-lock design which assures positive contact with board—yet will not cause damage to board paths, even after repeated insertions.

Assembly is easy: An A-MP high speed machine crimps contacts to circuit wires. Contacts are quickly and completely snapped into housing, locked in place with a lance to eliminate damage from shorts, bending or strain. The printed circuit board is then inserted for unlimited circuit combinations.

Snap in . . . clip in—it's that simple to save time, money and increase quality.

Send for full product information today.

You are cordially invited to visit us at the WESCON Show in San Francisco, August 18-21, 1959, Booths 2501, 2502, 2604.

AMP INCORPORATED

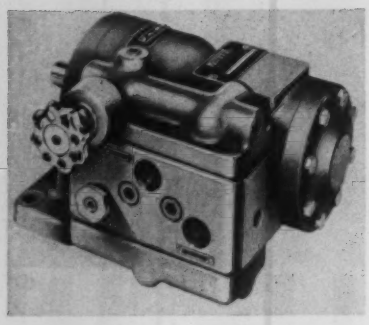
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

Circle 702 on Page 19

sign permits compact mounting of relays and the use of small panel enclosures. The units are of hinged aluminum modular construction with built-in wiring compartments. Relays are mounted on the top surface and control wires are contained under the devices. Each module swings out so the control wires can be snapped into place behind flexible vinyl retaining fingers. Units can be ganged in vertical or horizontal modular layouts or a combination of both. **Wyr-Way Inc.**, 250 Mt. Hope Ave., Rochester 3, N. Y.

Circle 429 on Page 19

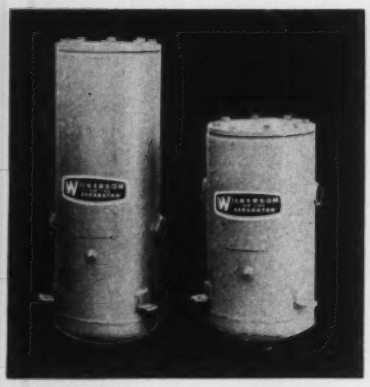


Two-Volume Pump

Item 430

Unit requires only a single pressure setting for both unloading and maximum pressure. It automatically maintains system pressure with a small volume pump while a fixed differential between the relief valve setting and the unloading valve allows return of large volume pump capacity to the reservoir at negligible pressure. The pump is recommended for 1000 psi at 1200 rpm in the small volume operation and up to 750 psi at 1200 rpm in the larger volume operation. Two pump groups are provided—one with 18 combinations of the small pump cartridges with capacities at operating pressure of 4.0 to 21.4 gpm for large volume operation and the second with 30 combinations of the small and large pump cartridges with capacities at operating pressures of 14.7 to 45.2 gpm for large volume operation. Either foot or flange mountings are available. **Vickers Inc., Div., Sperry Rand Corp.**, 1400 Oakman Blvd., Detroit 32, Mich.

Circle 430 on Page 19

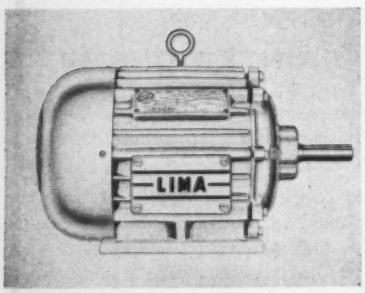


Air Cleaners and Dryers

Item 431

Unit, designated Mainliner, is capable of cleaning and drying the air that is used in compressed air systems. In addition to taking out moisture from air lines, the unit removes oil vapor and dirt particles as small as 3 mu. With the use of this device, cooling towers, water filtrations, pumps, and chemicals are eliminated. Various styles are available for removing oil fumes, water, and dirt, just water and dirt, or water only. **Wilkerson Corp.**, 1601 W. Girard Ave., Englewood, Colo.

Circle 431 on Page 19

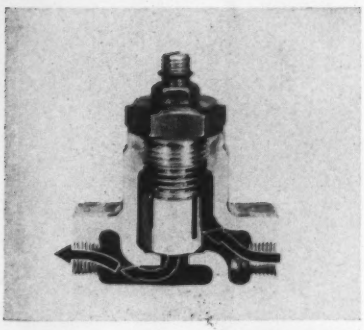


Explosion-Proof Motor

Item 432

Unit is suitable for use in locations where hazardous gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors, and natural gas are present. Motor is available in NEMA standard frames from 182 through 326U in ratings of 1 through 40 hp, either 3 or 2 phase, in all commercial frequencies and voltages below 600. Features of the motor frames are deep, integrally cast fins which provide extra cooling surface for rapid heat dissipation and an external fan which forces air at high velocity over the outside of the motor to provide constant cooling and a self-cleaning action. **Lima Electric Motor Co. Inc.**, subsidiary, Consolidated Diesel Electric Corp., Dept. 286, Lima, Ohio.

Circle 432 on Page 19

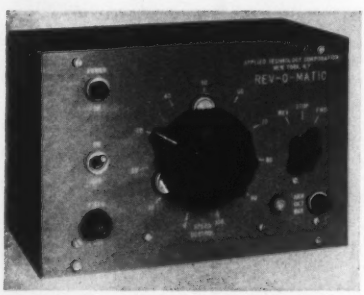


Speed Control Valve

Item 433

Feature of speed control valve is the use of a poppet that has four orifices of different lengths. The varied lengths of the four orifices permit micrometer adjustment of cylinder exhaust air flow from zero to full pipe capacity. Adjustment of the exhaust air flow through the four orifices is obtained by positioning the adjusting stem which increases or decreases the total orifice area. For pressure air flow in the opposite direction, the poppet lifts off the seat, providing unrestricted full pipe capacity air flow. Valve is a self cleaning type with a wiping action. **Automatic Valve Co.**, 37415 Grand River, Farmington, Mich.

Circle 433 on Page 19

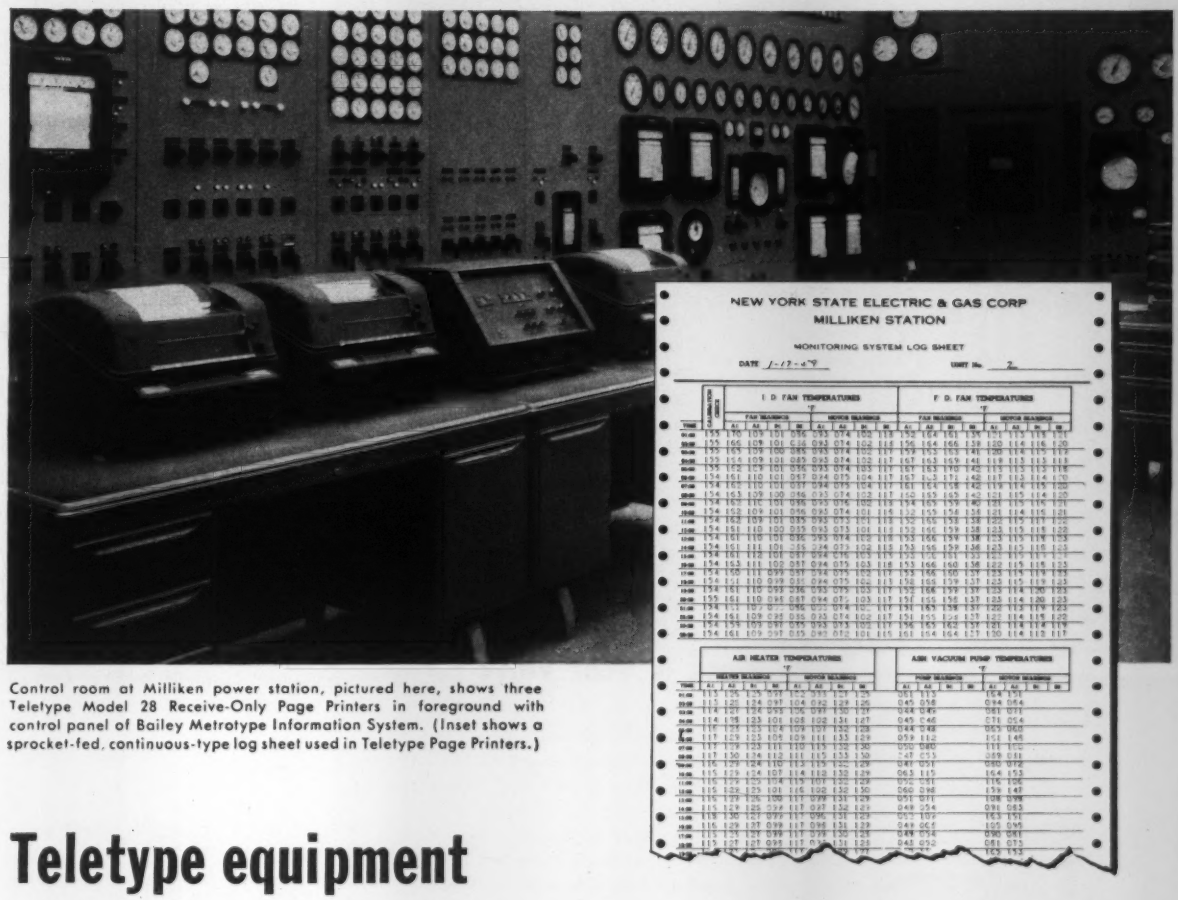


Variable Speed Drive

Item 434

Applicable on process machinery, metalworking machines, and mate-

Automatic read-out . . .


NEW YORK STATE ELECTRIC & GAS CORP
MILLIKEN STATION
MONITORING SYSTEM LOG SHEET
I. D. FAN TEMPERATURES
F. D. FAN TEMPERATURES
AIR HEATER TEMPERATURES
ASH VACUUM PUMP TEMPERATURES

Control room at Milliken power station, pictured here, shows three Teletype Model 28 Receive-Only Page Printers in foreground with control panel of Bailey Metrotype Information System. (Inset shows a sprocket-fed, continuous-type log sheet used in Teletype Page Printers.)

Teletype equipment monitors and records power station performance

New Model 28 Teletype Page Printers and Tape Punch equipment provide a continuous, dependable data processing facility for evaluating power station performance. This Teletype communication equipment is part of a Bailey Meter Company Metrotype® Information System installed recently at the Milliken power station of the New York State Electric & Gas Corporation, near Ithaca, New York.

This installation consists of two data systems:

1. A Monitoring System that continuously scans a total of 282 variables—temperatures of fan, motor and pump bearings; pressures of water and oil pumps, etc. Whenever readings exceed prescribed limits, system immediately reads and prints complete digital data of off-normal operation. In addition, complete readings are printed hourly.

2. A Performance System that scans 66 points once every hour, measures generator output, main steam flow, feedwater flow, temperatures, etc. All factors required to evaluate the station's performance are logged on the Teletype Printers. A Teletype Tape Punch also produces a perforated tape for IDP.

Robert Darke, Systems Division Manager, Bailey Meter, says, "Teletype equipment was chosen for this installation because of its flexibility and proven reliability. Design is simple and trouble-free, and the units are manufactured specifically for round-the-clock rather than intermittent service."

Teletype equipment will handle data for virtually any purpose in any industry. Signals may be serial or multi-wire. Signal medium may be local electrical circuit, telegraph or telephone circuit, or radio.

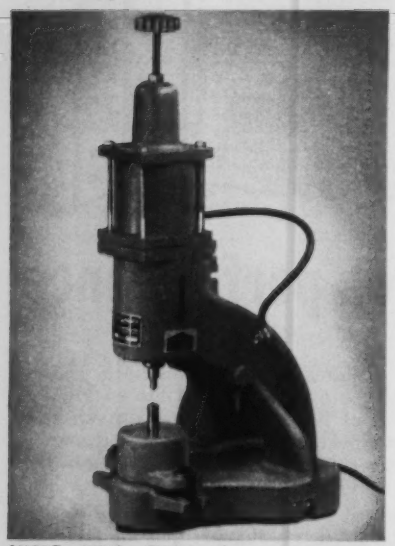
Why not find out how Teletype equipment can fit into your systems plan? Please write: Teletype Corporation, Dept. 21H, 4100 Fullerton Ave., Chicago 39, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

Circle 703 on Page 19

LOOKING FOR THE IDEAL TERMINAL SETTER?

STOP. *You've found it. A Black & Webster Electropunch or full automatic Electroset can solve your terminal setting problems — for as little as* **$135.00**



SHORT RUNS: Electropunch — *sets hand fed terminals twice as fast as conventional methods. All electric. Foot switch operated.*

LONG RUNS: Electroset — *automatically feeds and sets terminals up to 3600 per hour. All electric. Customized to your needs.*

WHAT'S YOUR PROBLEM?
Black & Webster can help. Send sample terminal and requirements.

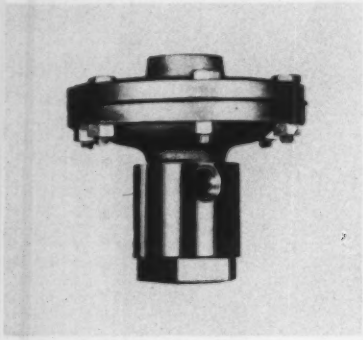
Write today for free 12-page catalog describing our complete line of production tools.

BLACK & WEBSTER, INC.
Dept. 2, 570 Pleasant Street
Watertown, Mass.—WA 6-0100

Circle 704 on Page 19

rial handling devices; line of variable speed drives is available in a horsepower range from 1/50 to 1/3. Model SC-31 Series features wide speed ranges with stepless adjustment from zero to full speed. Circuit breakers are used for armature protection. The remote control is small and compact. **Applied Technology Corp.**, 475 Fifth Ave., New York 17, N. Y.

Circle 434 on Page 19

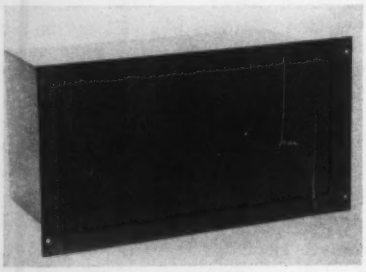


Block & Vent Valve

Item 435

Miniature block and vent valve controls air service using only one operator. Air flow is straight through at operator pressure of 5.5 psi or greater. As the operator pressure drops to 3.5 psi, air service is blocked and when it reaches 2 psi or less, the cavity between the blocked ports is vented to atmosphere. Body pressure rating for the 1/4-inch valve is 30 psi and the body temperature rating is for ambient air only. **Geo. W. Dahl Co. Inc.**, 86 Tupelo St., Bristol, R. I.

Circle 435 on Page 19

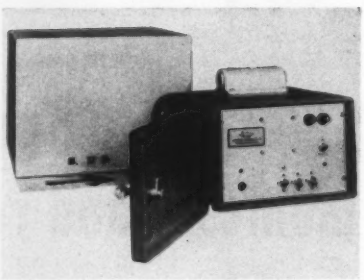


Telemetering Unit

Item 436

System, which consists of a transmitter and receiver (shown), is designed for sampling and telemetering remote measurements in oil and gas pipeline systems, power distribution systems, public utility systems, and industrial processes. It can transmit and receive, over a single teletype, voice, or microwave channel, up to 30 data points with an accuracy said to be better than 99 per cent. Output signal of the system is adaptable for computer control. A minimum data system of one point can be purchased and expanded in the field up to the maximum of 30 points for a single transmitter/receiver combination. Features of the system include: Automatic correction of system errors, positive system failure indicator, and hinged front panel allowing instant access to plug-in circuitry. Standard transducers can be used at the transmitter input and standard indicators can be connected to the receiver output. Milliameters, voltmeters, round or strip-chart recorders, or multipen recorders can be operated by the receiver. **Applied Science Corp. of America**, P. O. Box 44, Princeton, N. J.

Circle 436 on Page 19

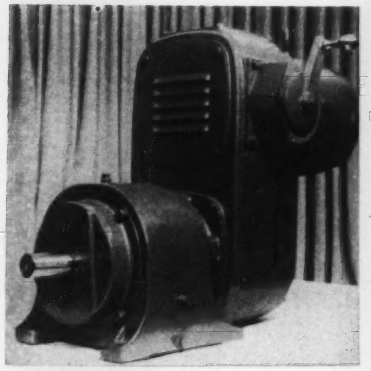


Carton Selector

Item 437

Suitable for automatic sorting, counting, and inventory control of packaged goods on an assembly line or conveyor, selector can recognize any one of 7 separate printed codes. The code consists of three parallel bars that can be printed either on the side or top of the carton. A self-contained light source illuminates a code printed on the carton so it can be read by photocells. Model 405 can be supplied with a counter and memory device for control of conveyors or switches that can be activated by an output signal. **Atronic Products Inc.**, Bala-Cynwyd, Pa.

Circle 437 on Page 19

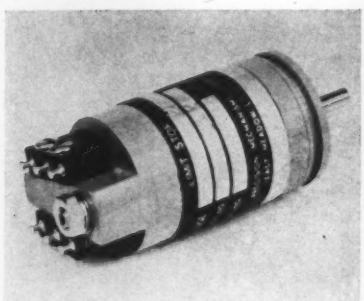


Adjustable Speed Drive

Item 438

Developed to operate on the v-belt connected, adjustable, variable pitch pulley principle, drive is available in sizes from ¼ to 25 hp, in output speeds ranging from 5 to over 4000 rpm. Features of the drive include: Automatic belt tensioning, ease of belt changing, and smooth operation of the stepless control mechanism. Actuating force of the drive is directed through an equalizer which prevents any binding or sticking of the speed control function. Some of the accessories for the unit are: Remote mechanical, remote electric, and pneumatic actuated controls. **General Electric Co.**, Schenectady 5, N. Y.

Circle 438 on Page 19



Rotary Limit Switch

Item 439

Infinitely adjustable limit switch-stop, designed for the servo and instrument industries, features a single exterior range adjustment screw which permits rapid adjustment to any angular rotation from zero to 25 turns. Limit switches are actuated at either end of shaft travel just prior to contact with nonlocking limiting stops. Switch-stop is 0.037-inch in diameter by 2 inches

NOW
A COMPLETE FAMILY OF SMALL AIR VALVES, MANIFOLDS, ACCESSORIES
Double solenoid, momentary contact (detented)
Single solenoid, spring return
Manifolds—four styles

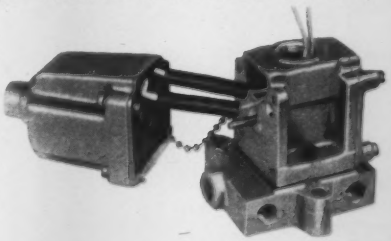
NUMATICS' New SA Junior Series

You've found it! . . . the answer to *all* your small air valve requirements. It's the new *SA Junior* Series . . . Numatics' small, precision-built, heavy duty family of valves and manifolds. Two valve types (above), many model varieties . . . three different sub-plates . . . three operator options and four styles of manifolds to provide application versatility unlimited.

SA Junior, what's more, gives you *quality* throughout . . . Numatics' famed patented lapped spool-floating sleeve action . . . corrosion-resistant aluminum body . . . continuously rated, heavy duty solenoids . . . J. I. C. conformance . . . all this plus a ruggedness and reliability to handle 60% of all your air jobs at an average 40% reduction in air valve costs. Send for a catalog today!

"Solenoid Capsule" Design—Another NUMATICS' FIRST!

Typical of SA Junior quality and design ingenuity is the unique, new "Solenoid Capsule" . . . a Numatics' *exclusive*. Solenoid and cover are a self-contained, J. I. C. approved assembly which eliminates loose parts when the solenoid cover is removed.

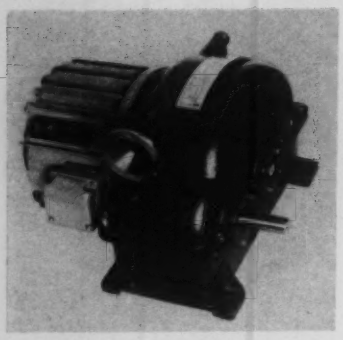


NUMATICS, Inc.
HIGHLAND, MICHIGAN

Circle 705 on Page 19

over-all length. Shaft diameter is 0.125-inch. Torque capacity is 40 oz-in. at end stops. **Precision Mechanisms Corp.**, 577 Newbridge Ave., East Meadow, N. Y.

Circle 439 on Page 19



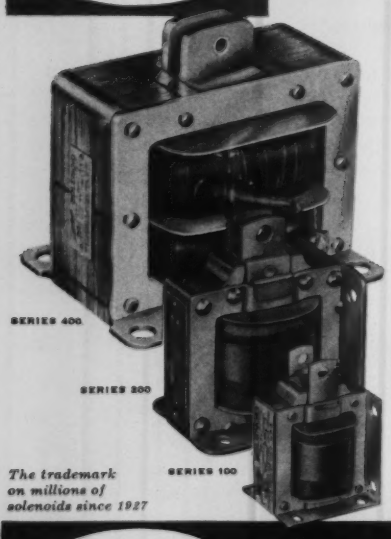
Adjustable Transmission

Item 440

Variable speed transmission features ratios up to 3:1 with a basically constant horsepower. Input power drives the toothed side of a belt through a timing belt pulley which gives constant fpm travel to the belt. Opposite side of belt is a flat bottomed V-shape which rides over two flat idler pulleys and a variable pitch output pulley. By proper positioning of the two idler pulleys, the toothed portion of the belt can be wrapped over the timing pulley and the vee portion over the variable pitch pulley. The idler pulleys are mounted on shafts which are supported on both ends in two adjustable plates. The idler carrying plates can be rotated about an axis which circumscribes a true arc with respect to the input pulley. As the plate assembly is rotated away from the variable speed pulley, the v-belt is drawn into the faces, separating them, and allowing the belt to operate at a smaller pitch diameter. To adjust the speed of Model 19000 (shown mounted with a motor), a segment of worm gear is mounted to one of the idler carrying side plates and is actuated by a worm. This is turned by the hand wheel on the unit or it can be motorized. Transmission will operate in a horizontal, vertical, angular, or inverted position. **Western Mfg. Co.**, 3400 Scotten Ave., Detroit 10, Mich.

Circle 440 on Page 19

WesCo has the AC solenoids you need... in the quantity you need!



The trademark on millions of solenoids since 1927

WesCo's famous Series 100, 200 and 400 AC solenoids—75 models in all—are immediately available in small or large quantities! One of these designs may fit your requirements. If not, WesCo engineers will design a special solenoid for your application. Inquire now.

WesCo designs and manufactures aircraft solenoids for military and commercial application. Write for complete catalog.

WesCo WEST COAST ELECTRICAL MFG. CORP.

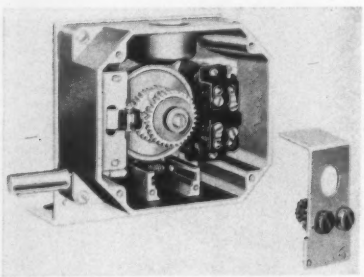
233 W. 116TH PLACE • DIVISION 122 • LOS ANGELES 61, CALIFORNIA • PLymouth 5-1138

Electronic Counter

Item 441

Line of electronic tachometers and frequency counters consists of 10 models designed to fit numerous industrial applications. Some of the units are self-contained, have remote indication, explosion-proof installation, and dual readout. Model 1316 (shown) is designed to use explosion-proof or remote readout unit. Various models have time bases with a fixed selectable time of 0.1, 0.5, and 1.0 second; 5 and 10 second extensions; fixed special time bases; and preset variable time bases on single, and multiple channels. Input can be sine waves, 5 to 150,000 cps, pulses, 0 to 150,000 cps, with accuracy of ± 1 count. Display time is adjustable from 0.1 to 10 seconds. **I-L-S Instrument Div., Meriam Instrument Co.**, 4526 W. 160th St., Cleveland 35, Ohio.

Circle 441 on Page 19



Rotating Shaft Switch

Item 442

Rotating shaft limit switch is adaptable for use as a pilot device for controlling ac or dc reversing starters or contactors that operate motors on machine tools, cranes, hoists, mechanical presses, conveyors, and valves. It is rated at 600 v maximum, is available in six gear ratios from 40:1 to 1080:1. When mechanically coupled to driving equipment, it eliminates the need of

from two to four remotely located switches. Limits are set by turning a screw. Accurate gear tolerance permits rapid reset characteristics. **Cutler-Hammer Inc.**, 315 N. 12th St., Milwaukee 1, Wis.

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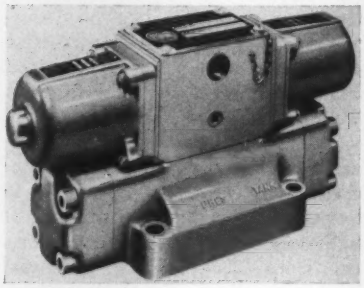

Solenoid Valve

Item 443

Four-way, ¾-inch valve will operate at 3000 psi, 20 gpm for pilot operated, solenoid controlled applications. Solenoids can be removed with the valve body for inspection without breaking primary electrical connections. The oil-immersed solenoid is housed in a sealed die cast housing, is dust and dirtproof. Provision is made for external tank porting when needed. The solenoid assembly is electrically connected by a bayonet-type receptacle similar to a common 110 v connection. **Hydraulic Press Mfg. Co., Div., Koehring Co.**, Mount Gilead, Ohio.

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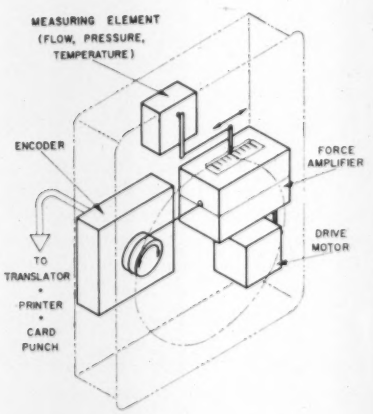


Digital Transducer

Item 444

Instrument can measure process variables, amplify the measurement mechanically, and provide digital encoding for flow, pressure, temperature, or liquid level. The primary measuring element can be a mercury or bellows type manometer for flow or liquid level, a Bourdon tube for pressure, or a filled thermal system for temperature. The measuring element is connected to a force amplifier which positions the shaft of an encoder. The encoder output can be connected to a translator for visual readout or other equipment for printout, data handling, or control. Precision encoding at the balance or null position is obtained because the force amplifier develops its maximum output at this position. Transducer is rated with an accuracy of ±1 per cent of span; reproducibility is better than ±0.5 per cent of span. It will operate on 110 v, 60 cycles, drawing approximately 20 w. **American Meter Co.**, P. O. Box 309, Garland, Tex.

Circle 444 on Page 19

As easy as plugging in your electric shaver...

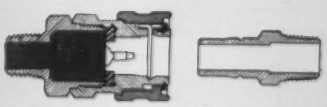
Wherever you use compressed air...

...just

PLUG IN THE POWER

- Tough...compact...smaller...lighter.
- Handles more air—with minimum pressure drop.
- Quick connection and disconnection.
- Instant automatic flow or shut-off.
- Handles any job in your shop using ¾" to ⅛" connections—from the air line to the air tool.
- Locking ring provides positive lock ... tight fit. Equipped with automatic sleeve lock.
- All Series 2-RL Sockets and Plugs are interchangeable—likewise all Series 3-RL Sockets and Plugs. Eliminates all need for various size couplings in hook-up—makes it easy to keep stock of parts in balance—holds inventories to a minimum.

with the HANSEN Series RL QUICK-CONNECTIVE Ring-Lock Coupling



Socket, when disconnected, automatically shuts off air by leak-proof seal of metal valve against rubber valve seat.

Write for the Hansen Catalog... a ready reference when you want information on couplings in a hurry.

Quick-Connective Fluid Line Couplings for AIR • OIL • GREASE • HYDRAULIC FLUIDS WATER • VACUUM • STEAM • OXYGEN • ACETYLENE REFRIGERANTS • GASOLINE • COOLANTS • LP-GAS

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QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

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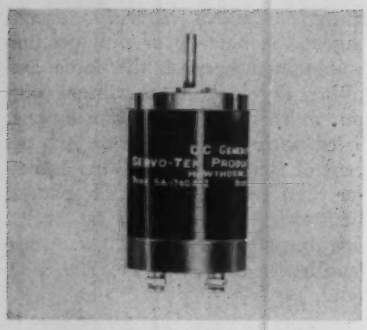
Circle 707 on Page 19

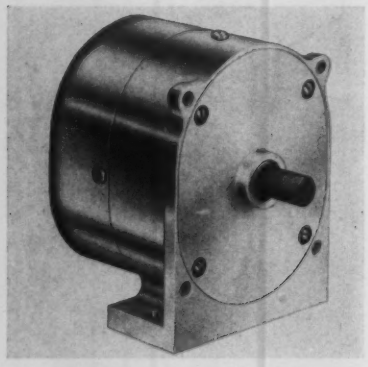


Tachometer Generator

Item 445

Device is constructed of special brush materials to guarantee a brush life of 100,000 hours of continuous operation at 3600 rpm. The commutator is fabricated from an alloy containing more than 85 per cent pure silver. Linearity from 0 to 12,000 rpm is better than 1/10 of 1 per cent of the voltage output at 3600 rpm. **Servo-Tek Products Co.**, 1086 Goffle Rd., Hawthorne, N. J.

Circle 445 on Page 19



Gear Motor

Item 446

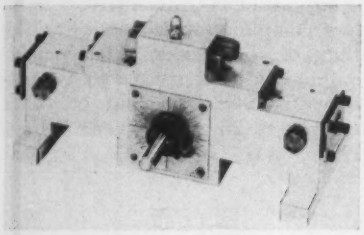
Designed to power machine tools, pumps, and conveyors; gear motor is available at any single speed from ½ rpm to 1000 rpm with torques to 1/20 hp and 175 lb-in. at 10 rpm. Model HD is totally enclosed, features a continual airflow over the motor. It can be mounted vertically, horizontally, upside down, or in any position. The two-pole, shaded pole unit is rated for 115 v, 60 cycle—by special order it is available for 6 to 440 v and 25 to 80 cycles. **New England Gear Works**, South End Rd., Southington, Conn.

Circle 446 on Page 19

Rotary Torque Unit

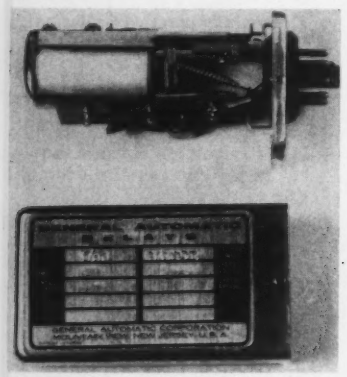
Item 447

Operating at a power input range from 50 to 1000 psi, rotary torque unit can convert hydraulic pressure into reciprocating rotary motion that can be regulated to fit most



job requirements. With power output at 1000 psi, hydraulic pressure will provide 500 in.-lb of working torque over a range of rotation from 5 to 360 degrees. Built-in speed adjustments allow complete control of rotary shaft speed in either or both directions. Electric solenoid actuation is also available for either or both directions of rotation. For special applications where hydraulic power is not available or practical, unit is adaptable for use with air power or vacuum. **Industrial Sales Div., Cleveland Pneumatic Industries Inc.**, 64 Old Orchard, Skokie, Ill.

Circle 447 on Page 19

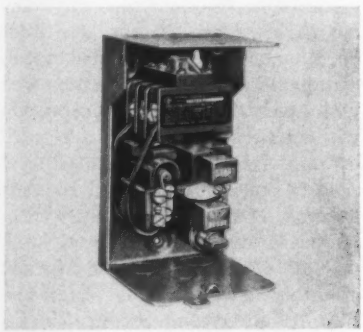


Transistor Relay

Item 448

Power sensitivity of transistor amplified relay is less than 10 mu w for positive relay operation. Unit is applicable for photocell sensing, liquid level detecting, as a limit control for machine tools, or on fire and burglar alarm systems. Current sensitivity is 10 microamperes at 1 v dc, or an equivalent input resistance of 100,000 ohms. Contact arrangements are SPDT (1 Form C) or DPDT (2 Form C) for contact loads up to 3 amp at 115 v ac or 29 v dc noninductive. Contact materials can be silver, silver palladium alloy, palladium or gold alloy. The gold alloy is recommended for dry circuit or low level applications. The bias voltage requirement is 16-25 v positive dc—this voltage can be supplied from an external source or from an internal mercury battery. Relay is designed with a thorough wiping action on the contacts; has an operating life which is said to be in excess of 25 million operations. It will operate in temperatures ranging from 32 to 112 F. **General Automatic Corp.**, 12 Carlton Ave., Mountain View, Wayne, N. J.

Circle 448 on Page 19



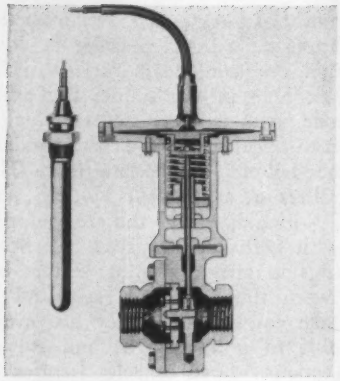
Manual Starter

Item 449

Electrical manual starter is adaptable for controlling electric motors used on metal and woodworking machinery, grinders, power saws, buffers, conveyors, fans, pumps, and compressors. It provides 2, 3, or 4 poles for control of motors through 5 hp single phase, 7½ hp 550 v polyphase, and 2 hp 230 v dc.

Starter has only two moving parts. A mechanical direct acting thermal overload operates independently of the second overload or pushbutton mechanism. The overload unit makes it impossible for the operator to hold the circuit closed against overload. An available accessory for precise jogging on ac applications is a *Jog-Run* device. When in *Jog* position, contact is made only while the *Start* button is held in the depressed position. **Furnas Electric Co.**, 1128 McKee St., Batavia, Ill.

Circle 449 on Page 19

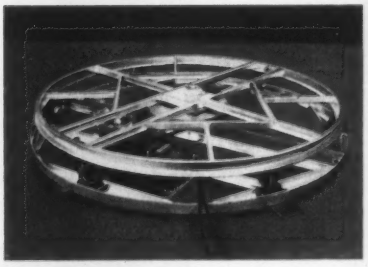


Temperature Control

Item 450

Feature of temperature control valve is the removable thermal system which allows field changing of temperature control ranges without affecting the valve stroke. Other features of the unit include tamperproof thermal system and self cleaning sliding gate seals for tight shut off and linear flow. Model 180 is furnished in sizes ranging from ¼ through 2 inches. It is rated for temperatures to 450 F and pressures to 250 psi. Temperatures can be controlled from 35 to 450 F. **OPW-Jordan,** 6013 Wiehe Rd., Cincinnati 13, Ohio.

Circle 450 on Page 19



Turntable

Item 451

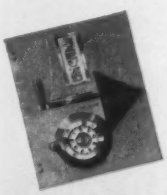
Line of turntables is available in sizes up to 16 ft in diameter, with load-carrying capacities up to 3 tons. Unit consists of an assembly of 5 pieces; 2 upper circle halves, 2 lower circle halves, and a sprocket and center bearing assembly. It can be used in either permanent or temporary installations. If excessive torque builds up due to jamming, it causes the clutch to slip, thereby protecting the gear reducer and drive motor from overloads. Once

REEVES® *Vari-Speed Motodrives*

mean versatility in variable speed

There's a *standard* REEVES Motodrive for virtually *any* installation. Rugged, compact variable speed . . . ¼ to 20 hp. . . . 1.7 to 4660 rpm. . . . 2:1 thru 10:1 speed variation. Other units up to 40 hp. There's space-saving versatility, too. Choose either "C" flow style (illustrated) or "Z" flow (motor on opposite side of case from output shaft).

Extra precision . . . a complete line of controls, ie. AIRtrol (a pneumatic positioner), electric remote control, mechanical controls, magnetic brakes and tachometers. **Extra versatility** . . . to meet specific needs, REEVES offers a full array of modifications, ie. special motors, shaft extensions and scoop mountings for foot-mounted motors.



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Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.
COLUMBUS, INDIANA
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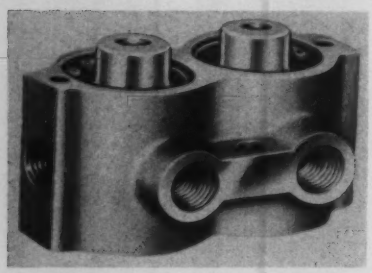
R MASTER REEVES

Circle 708 on Page 19

the jam is corrected, the clutch automatically resets itself in driving position and normal operation resumes. Input power can be 110, 220, or 440 v. **Anchor Steel & Conveyor Co.**, 6906 Kingsley Ave., Dearborn, Mich.

Circle 451 on Page 19

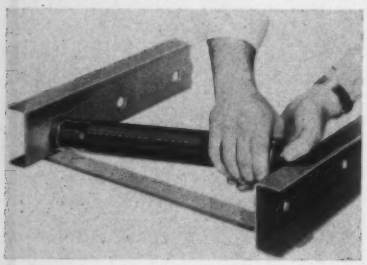


Pilot Operated Valve

Item 452

Line of pilot operated valves is suitable for automatic control of air, gas, vacuum, and liquid flow for pressure to 125 psi. Buna N diaphragms cycle from full open to dead seal shut-off at up to 30,000 cycles per hour. Opening, closing, and exhausting are powered by line pressure and require only a triggering impulse. Valves are available in 1/8, 1/4, and 1/2-inch sizes, in 2, 3, and 4-way styles. Bodies of the valves can be machined solid steel, cadmium-plated high tensile iron, or cast brass. They will operate in temperatures ranging from −65 to 225 F. Model 400-FX (shown) is a 4-way, 5-port unit designed for operating double action cylinders. **Humphrey Products, Div., General Gas Light Co.**, 202-L N. Park St., Kalamazoo, Mich.

Circle 452 on Page 19



Conveyor Roller

Item 453

Unit features a spring-retained axle for easy mounting and removal of individual rollers from the frame. To insert a roller in position, one axle end is inserted in the hex hole in the frame; the other axle end is depressed manually, then released into the corresponding hex hole in the opposite frame. The rollers are available in 1 7/8, 2 1/4, and 2 1/2-inch diameters and are equipped with high capacity steel ball bearings to give two-point contact between the balls and races and to take end thrust. They are available in both straight and curved sections. Load capacity is rated at approximately 150 to 250 lb per roller. When changing rollers, the spring retainer keeps the axle in place, eliminating the job of putting the axle back through the assembly. **Alvey-Ferguson Co.**, 3311 Disney St., Cincinnati 9, Ohio.

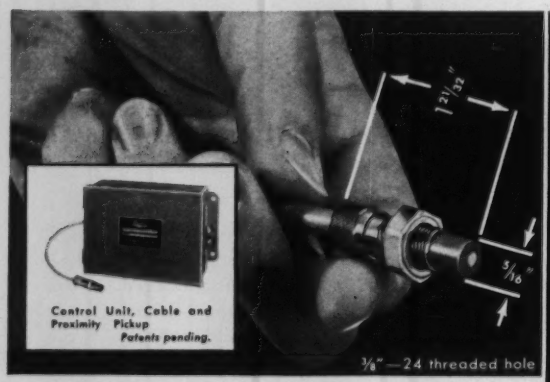
Circle 453 on Page 19

Silicone Rubber Wire

Item 454

Line of silicone rubber wire is constructed for use as hook-up wire, apparatus lead wire, aircraft wire, power cable, ignition cable, electronic hook-up wire, fixture wire, and shipboard cable. Some of the features of the wire are its heat resistance, low temperature flexibility, ozone resistance, electrical stability, solderability, and thermal conductivity. Although specified for 200 C continuous operation, the silicone rubber can maintain its physical and electrical properties after a short time exposure at 315 C. The silicone rubber insulation produces an ash when it is burned. This ash which is held in place with fiberglass braids, will continue to be an insulator. **American Super-Temperature Wires Inc.**, Winooski, Vt.

Circle 454 on Page 19



Solve your metal control problems with this low cost proximity pickup

Compare these advantages over other proximity devices

• Detects ferrous and non-ferrous metals • Sensitive to tin foil • Control Unit can be located 50 feet or more from pickup • Replacement cost only $13.50 • Pickups sealed against water and oil • Meets JIC requirements. Variety of models for detecting metal objects at clearances over six inches; also Hollow Coil Pickups for detecting and counting small metal parts.

Control Unit contains relay output for direct operation of motor controls, solenoids and electric counters.

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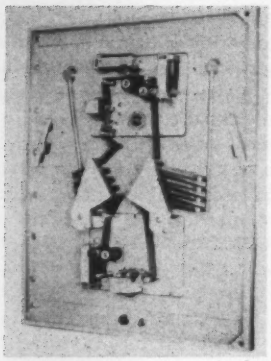
pickups are unaffected by nearby 60 cycle AC fields

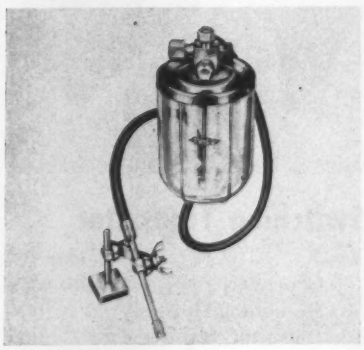


Digital Loop Transport

Item 455

Digital magnetic tape loop transport, designated Model 3269, is capable of performing operations such as data format conversion, data rate changing, serial to parallel and parallel to serial conversions, fixed or variable time delay, sorting and correlations analysis input. Either one tape drive plate or two independent tape drive plates with isolating slack loop system can be used. Each tape drive plate can contain one or more capstans. The capstan speed and direction of rotation can be independently specified for each capstan. Unit can be used with any company record-playback head. **Potter Instrument Co. Inc.**, Sunnyside Boulevard, Plainview, N. Y.

Circle 455 on Page 19

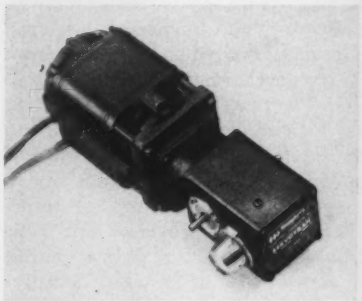


Mist Coolant System

Item 456

Coolant unit is suitable for use on small machinery used for precision drilling, tapping, milling, sawing, and grinding operations. Unit, designated Type J, has a 2 ft coolant line and a mist generating nozzle. It has dual valve controls —one to control air and the other to control the flow of liquid coolant dispensed at the tip of the mist generating nozzle. The magnetic nozzle holder has an adjustable arm so that the coolant can be directed to the cutting edge of the tool. The tip of the nozzle is protected against damage by a special guard. A ¼-inch compression fitting will receive shop air of 50 to 125 lb. The shatterproof plastic reservoir holds 8 oz of coolant. When a fine mist is used, this supply usually lasts a full day. **Trico Fuse Mfg. Co.**, 2948 N. Fifth St., Milwaukee 12, Wis.

Circle 456 on Page 19



Variable Speed Drive

Item 457

Drive can provide output shaft speeds infinitely variable from zero to 1200 rpm, forward and reverse. Models are available for power ratings from 1/1000 to 1/10 hp. It is adaptable for use with automatic equipment, chart drives in recording instruments, remote controls, computers, and machine tool feeds. Feature of the drive is the calibrated, venier, ten-turn dial by which speed settings or duplication of previous speed settings can be set by finger tip adjustment. If the unit is needed as an integrator, a ten-turn control shaft can be substituted for the ten-turn dial. By substituting a direct acting lever for the dial on the control arm, the drive can be shifted from full speed forward to full speed reverse in 0.05 seconds. Control shaft movement is ±10 degrees, and control torque required is less than 2 in.-oz.—output torque is adjustable. **Humphrey Products Div., Humphrey Inc.**, 3794 Rosecrans St., San Diego 10, Calif.

Circle 457 on Page 19

A LOT OF CONTROL IN A SMALL SPACE

DAHL
"BANTAM" VALVES

Dahl "Bantam" 2020, 2030 and 2031 series are highly compact, diaphragm-operated on-off valves. Each features the desired ruggedness and high quality of larger valves, and yet, allows appreciable savings in space. All have cast globe bodies for steam, liquid or gas applications.

"Bantam" valves have excellent flow characteristics, low hysteresis and fast response. Use of TEFLON® packings eliminates frequent packing adjustment and greatly reduces maintenance.

MAXIMUM Cv	40.0
LIFT	⅜"
SEAT AREA	up to 3.1 sq. in.
CONNECTIONS	¼" to 2" N.P.T.
PRESSURE RATING	150 psi for steam 300 psi for liquid & gas
OPERATORS	8, 15, 50 sq. in.

For more detailed information on "BANTAM" On-Off and Throttling Control Valves write for . . . . . Catalog B-1.

GEORGE W.
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Circle 710 on Page 19

INDUSTRIAL MARKETING MANAGER

PROMINENT defense producer in the field of precision-engineered electro-mechanical controls and systems is creating the new position of Industrial Marketing Manager, who will plan and develop industrial and commercial outlets for its products. His basic responsibilities will be:

NEW PRODUCT SELECTION AND PROGRAMMING, comprising product searches, market research, product recommendations, 5-year projections of market potentials, production space and personnel requirements, etc;

NEW PRODUCT MARKETING, including development of sales policy and organization, selection of distribution channels, creation of sales promotion and advertising programs, etc.

APPLICANT should have at least five years successful industrial sales management experience, preferably in field of industrial controls and precision engineered products, including market research techniques, industrial advertising, sales promotion and training. Degree in engineering sciences desirable. Age 35-50 years. Salary open—commensurate with qualifications.

Send resume to:

BOX 318 A
667 Madison Avenue
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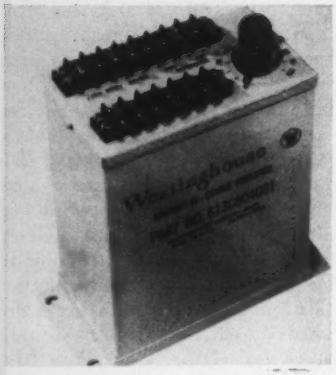
Circle 711 on Page 19

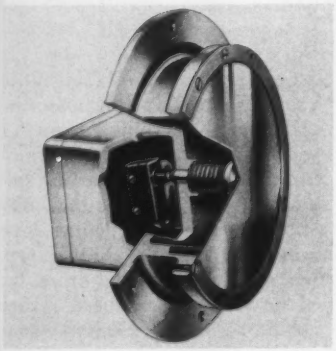


Static Relay

Item 458

Bistable magnetic amplifier can be used as a sensitive static relay in indicating and regulating systems. The amplifier, when operating from a low-level sensing element, will drive a power amplifier stage to serve as a regulating system for use in both proportional and *On-Off* systems. The combination of a magnetic amplifier and a transistor amplifier provides four control inputs and a power output of zero or 5 w at 24 v dc. Sensitivity is 0.05 mu w; average response time is 20 milliseconds; and the range of input impedance is 1 ohm to 1 megohm. An optional feature is a potentiometer-controlled reference supply which permits the amplifier to operate on base voltage other than zero. **Westinghouse Electric Corp.**, Director Systems Dept., 256 Collins Ave., Pittsburgh 6, Pa.

Circle 458 on Page 19



Bin Level Indicator

Item 459

Corrosion resistant unit is suitable for applications where corrosion and chemical action may be present. The controlled movement of the spring-loaded stainless steel diaphragm and the sensitivity of the switch mechanism makes it responsive to changes in the pressure of materials. It will function effectively in controlling levels of light, low density materials or in controlling heavy, dense, coarse, or abrasive materials.

The indicator can be fastened to thick or thin walled bins, or suspended within the bin, hopper, or silo at any desired level by means of a simple extension. It can also be used in chutes and hoppers to prevent choke-ups, overfeeding, and damage to machinery. In operation, the pressure of material against the stainless steel diaphragm actuates a switch which operates signals such as lights, bells, or horns. It can also be set to automatically start or stop the flow of material into or out of the bin and stop or start filling machinery. When installed in the cover of conveyors, it will detect any tendency of overfilling or packing and shut off the feed of material. **Bin-Dicator Co.**, 13946-209 Kercheval, Detroit 15, Mich.

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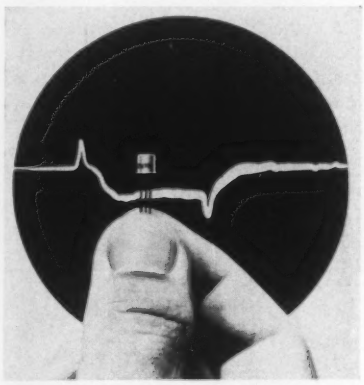


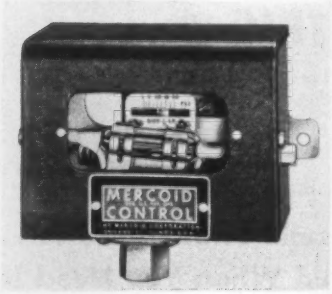
Switching Transistor

Item 460

Produced by the gaseous-diffusion process, subminiature silicon switching transistor features typical total switching speeds as fast as 25 millimicroseconds, with a guaranteed dc beta range. The gaseous-diffusion process is used to produce the unit and provide high performance and outstanding reliability through close production control. Model TI 2N702 dissipates 150 milliwatts at 100 degrees in free air. It has a dc beta spread of 15 to 45 and a maximum collector cutoff current of 0.5 micro-

amps. Minimum breakdown voltage is 20 v and maximum saturation voltage is 0.6 v. **Texas Instruments Inc.**, P. O. Box 312, Dallas, Tex.

Circle 460 on Page 19

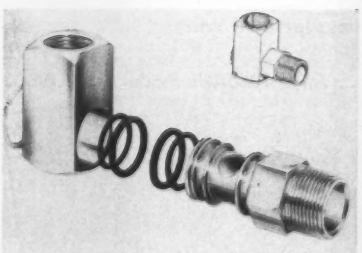


Pressure Control

Item 461

Adaptable for use in air, liquids, or gases; miniature pressure control is particularly suitable for applications where only limited space is available or for mounting on wiring channels. Features of Model AP-153 include external adjustment, repetitive trip point, visible calibrated dial with pointer, and visible hermetically sealed mercury contacts. Pressure element is a Fairprene diaphragm. The operating range is adjustable from 1 to 20 psig, differential is fixed at 0.5 psig; maximum pressure is 30 psig. Control has two mounting ears (one on each side of the case) or it can be mounted by means of ¼ ips bottom connection. Switch is SPDT rated 4-amp 115 v, 2 amp 230 v. **Mercoid Corp.**, 4201 Belmont Ave., Chicago 41, Ill.

Circle 461 on Page 19



Swivel Connector

Item 462

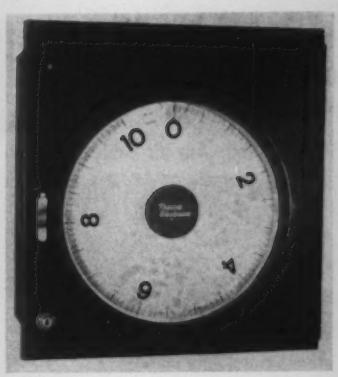
Device is capable of delivering hydraulic fluid, under pressure, at any angle. It is suitable for use on cranes, loaders, earth moving equipment, hydraulic presses, and shears. The 90 degree connector is designed to provide low torque operation and freedom from friction even at high pressures up to 5000 psi. The interior construction allows a balanced flow of hydraulic fluid, causing the body to float around the stem, free of any end load or friction. Fluid pressure is absorbed equally by a double seal at each end of the stem. Combinations of stems can be interchanged with any body style. Various thread styles are available in sizes ranging from ½ through 1½ inches. **Eastman Mfg. Co.** Manitowoc, Wis.

Circle 462 on Page 19

Indicating Controller

Item 463

Instrument can indicate and control any variable that can be converted into an electrical quantity, such as dc potential, current, or resistance. Controller features a high-gain servo amplifier to provide sensitivity and stability and maintain operating characteristics under conditions such as high external resistance, wide line voltage fluctuation, and electrical interference. Amplifier's stability is ±1 mu v; sensitivity is 1 mu v, power gain is 135 db and voltage gain is 100,000-000 at rated load. Numerous types of scales are available including a 1 mv minimum span. Calibration is said to be accurate within ±0.25 per cent of the full scale span, or 5 mu v. Up to 6 alarm contacts can be provided to which external light or audible alarms can be connected. **Thermo Electric Co. Inc.**, Saddle Brook, N. J.



Circle 463 on Page 19

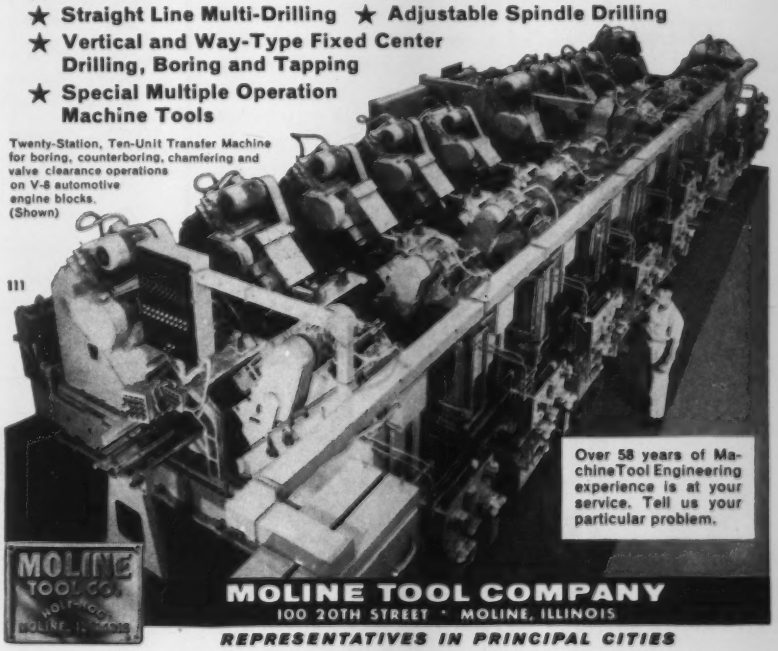
MOLINE

FOR GREATER PRODUCTION • EFFICIENCY • SAVINGS

Use rugged, reliable "Hole Hog" machine tools for such jobs as:

★ Multi-Spindle Boring ★ Single and Multi-Spindle Honing
★ Straight Line Multi-Drilling ★ Adjustable Spindle Drilling
★ Vertical and Way-Type Fixed Center Drilling, Boring and Tapping
★ Special Multiple Operation Machine Tools

Twenty-Station, Ten-Unit Transfer Machine for boring, counterboring, chamfering and valve clearance operations on V-8 automotive engine blocks. (Shown)



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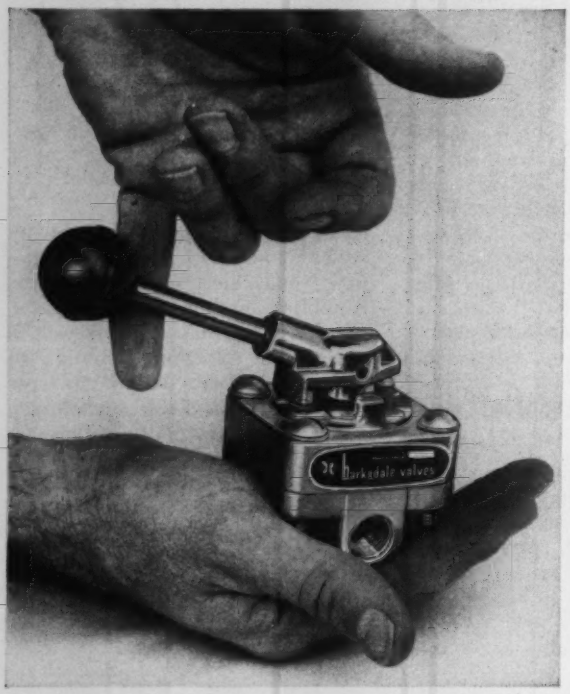
REPRESENTATIVES IN PRINCIPAL CITIES

Circle 712 on Page 19

AIR VALVES
FOR THE NERVE CENTERS OF PRODUCTION

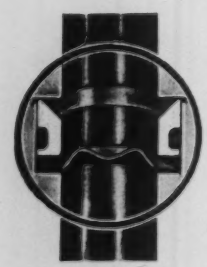
IN BARKSDALE **'AIR-SEAL'** VALVES
THE AIR PRESSURE IS THE SEALING FORCE
THE HIGHER THE PRESSURE, THE TIGHTER THE SEAL

250 P. S. I. four-way air valves in ¼, ⅜ and ½ inch pipe sizes.



This is a re-design of our proven 250 P. S. I. air valve.

NEW FACE LIFT results in LOWER PRICE



None of the operating advantages of this rugged *'Shear-Seal'* valve has been reduced one iota!

. . . same non-corrosive construction throughout — eliminates failures due to rust.

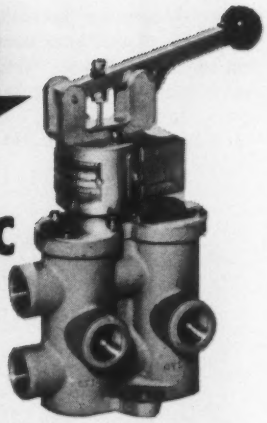
. . . same long wearing leak-proof qualities — metal to metal *'Shear-Seal'* design is not sensitive to dirt, compensates for wear.

. . . same installation savings — because no oilers or filters are needed.

Only the exterior has been modified — tailored to the special preference of the Original Equipment Manufacturers — and, as a result, costs and prices have been substantially reduced. *Write for bulletin 5000 which includes design specs.*

CONTROL VALVE DIVISION
barksdale valves
5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

NEW MANU-LECTRIC VALVE



Normally Solenoid Pilot Operated... Hand Controlled When You Need It!

The valve can be actuated by hand, whether the coil is energized or de-energized.

This provides advantages not usually found in ordinary valves:

★ On die setting and clamping set-ups requiring skill and judgment, the manu-lectric valve gives the accuracy and safety of manual control during the critical alignment stage before letting power operation take over.

★ On jobs where cement or powdery substances are handled, the manual control override enables the operator to "work" hopper doors and free a sticking batch without interrupting the electrical cycle.

★ Operational or electrical failures in the system can be easily checked without the need for halting production runs.

★ For situations where manual control is merely an emergency feature, the manual lever can be safety-wired to prevent accidental actuation.

Whether manual control is an integral function of your production set-up or called for only on rare emergency occasions, it will pay to install manu-lectric valves.

Compare the advantages . . . at so little additional cost!

½" Solenoid Pilot Operated Valve
1046AH Model $59.75
½" Manu-Lectric Valve 1046AHL Model 66.00

Write for Air Valve Catalog 9-AV

CONTROL VALVE DIVISION
barksdale valves
5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

catalogs and literature

Latest automation information. For copies use card on page 19.

Indexing Mechanisms

Ferguson Machine Corp. of Indiana, 7818 Maplewood Industrial Court, St. Louis 17, Mo.—24 page catalog—Data are given in Catalog 108 on high speed, precision, roller gear drive indexing mechanisms for achieving intermittent and oscillating motions. Units described are rated for speeds up to 2000 indexes a minute with precision of 0.001-inch and zero backlash for 8000 to 20,000 hours operation. Details are included on how to calculate load requirements and design an installation.

Circle 464 on Page 19

Form Printer

Electronics Div., Clary Corp., 408 Junipero St., San Gabriel, Calif.—10 page bulletin—Model 1941 which prints electronically controlled data on preprinted forms, tags, or labels is the subject of Bulletin S-112. Principle of operation is explained, and charts list electrical and timing characteristics. Schematic diagram shows the wiring setup for the printer.

Circle 465 on Page 19

Slitting Equipment

Yoder Co., 5500 Walworth Ave., Cleveland 2, Ohio—76 page catalog—Slitting equipment for coils and sheets is described in Bulletin 700-4M. Types include uncoilers, slitters, recoilers, coil cars, and scrap choppers. The bases of capacity ratings and how to use capacity tables are explained. Data are given on design, selection, and operations of slitters and slitting lines, including time studies and analysis of operating cycle. Also discussed are coil handling and scrap disposal methods.

Circle 466 on Page 19

Breadboard Parts

Helipot Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.—24 page catalog — Electromechanical breadboard parts described in Catalog 575 are suitable for use in applications such as servo design and analysis, process control, and analog computer system design. Data are given on all parts necessary for the assembly of gear trains and servomechanisms. Schematic diagrams show basic synchro transmitter and receiver systems, potentiometer transmitter and receiver systems, and a mechanical resolver system.

Circle 467 on Page 19

Overhead Handling Equipment

Cleveland Tramrail Div., Cleveland Crane & Engineering Co., 1036 E. 289th St., Wickliffe, Ohio—12 page booklet—Overhead materials handling equipment is covered in Bulletin 2008-0. Types of equipment discussed include carriers, cranes, tractors, track switches, and grabs. Details are given on track design, peening, and stresses. Installation photos are also included.

Circle 468 on Page 19

Roller Bearings

Rollway Bearing Co. Inc., 541 Seymour St., Syracuse 4, N. Y.—16 page booklet—Data on line of roller bearings is contained in Catalog PL-559. Some of the types of bearings described include precision radial, precision thrust, steel cage, cartridge, and traction motor. Also discussed are bearings for special applications where race configuration, material, or construction are factors. The company's manufacturing, research, design, and testing facilities are noted.

Circle 469 on Page 19

Worm Gear Jacks

Duff-Norton Co., P. O. Box 1889, Pittsburgh 30, Pa.—8 page bulletin—Specifications and applications are given in Bulletin AD-66a for eight worm gear jacks ranging in capacity from 2 to 100 tons. Engineering drawings and application photos are given. Notes are also included on four mitre gear box assemblies.

Circle 470 on Page 19

Water & Oiltight Limit Switches

National Acme Co., 170 E. 131st St., Cleveland 8, Ohio—16 page booklet—Line of heavy-duty water and oiltight limit switches in single-pole, double-break, double-throw design is described in Bulletin EM-5912. Types of styles include standard, neutral position, short travel, and push lever. Sketches of the switches in half-scale size are included to permit the engineer to trace the units directly on a layout. Notes are also given on water resistant enclosure, explosion resistant, and reversed lever limit switches.

Circle 471 on Page 19

Tape Controlled Machine

Burg Tool Mfg. Co. Inc., 15001 S. Figueroa St., Gardena, Calif.—12 page booklet—Data are given on the Electropoint system which is an automatic tape control system for positioning the machine table and operating the hydraulic machine to carry out a predetermined sequence of operations. The operations can include drilling, boring, tapping, reaming, counterboring, and spot facing. Principle of operation is explained and details are given on the features of the unit. Also included is a functional diagram of a digital drill control.

Circle 472 on Page 19

Variable-Speed Drives

Sterling Electric Motors Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.—8 page bulletin—Variable speed drives suitable for use in metal working, mixing, pumping, materials handling, and continuous processing operations are outlined in Bulletin 195. Illustration shows a separate motor drive horizontal assembly and a cutaway photo shows the operating mechanism of the drive. Speed variation, mounting styles, and electrical characteristics are listed.

Circle 473 on Page 19

Temperature Transmitter

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—4 page pamphlet—Details are given in Bulletin P51-4 on a helium gas-filled system for measuring temperature from 0 to 1200 F and transmitting it pneumatically to indicating, recording, and controlling equipment at remote stations. Operating characteristics and installation requirements are listed along with standard ranges and accessories.

Circle 474 on Page 19

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Circle 714 on Page 19

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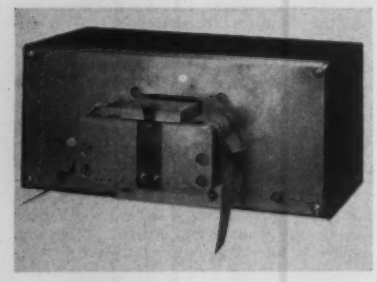

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Circle 715 on Page 19

Two Component Blender

B-I-F Industries Inc., 345 Harris Ave., Providence, R. I.—8 page bulletin—Model TC, a two component blender for the controlled measuring and blending of two liquids, is the subject of Bulletin SM-2070. Two types of the blenders are discussed—the flow responsive blender which automatically varies its output to demand and the controlled rate blender which will maintain a set rate in spite of supply fluctuation or changes in downstream pressure. Diagrams show methods of hook-up to existing pumps or independent supply pumps and a sample hook-up for blending two base components and an additive.

Circle 475 on Page 19

Lubricating Equipment

Gray Co. Inc., 1030 Sibley St. N. E., Minneapolis 13, Minn.—16 page booklet—Automatic, air-powered, and hand operated lubrication equipment is outlined in Catalog Section D. Some of the types of units described include high pressure lube pump and drum cleaners, supply pumps, elevators and portable lubricators, and gun filled lubricators for automatic machine bearing lubrication. Notes are given on a selection of fittings, hose, and accessories.

Circle 476 on Page 19

Electromagnetic Pulleys

Stearns Magnetic Products, 635 S. 28th St., Milwaukee 46, Wis.—8 page bulletin—Electromagnetic pulleys are described in Bulletin 1011. The application of magnetic pulleys in modern process industries is explained and the principle of operation is outlined. A cutaway photo shows the performance features and notes are given on how to select the proper pulley.

Circle 477 on Page 19

Data Processing System

Remington Rand, Div., Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.—55 page handbook—A data processing computing system, designated Univac 1105, is the subject of Bulletin U1661. Design of the system is explained, and its adaptation to the needs of large and small businesses and industry is noted. Features described include internal operating speeds, input-output facilities, programming details and operating characteristics. Details are given on applications such as data reduction, data processing and analysis, and real-time operation of process plants.

Circle 478 on Page 19

Single Spindle Bar Automatics

Cleveland Automatic Machine Co., 4932 Beech St., Cincinnati 12, Ohio—4 page pamphlet—Single spindle bar automatics in 1⅝ and 2½ inch capacity are described in Bulletin B-359. The machines are suitable for work involving multiple diameters, shoulders, and tapers. Operating features are explained and illustrated and specifications given. Data are also included on a cross slide turning attachment and hopper magazines for second operation work.

Circle 479 on Page 19

Hydraulic Valves & Accessories

Waterman Engineering Co., 725 Custer Ave., Evanston, Ill.—12 page booklet—Line filters, check valves, unloading valves, relief valves, and fuses for hydraulic power systems are outlined in Catalog 3000. Filters listed in the catalog are rated for hydraulic pressures to 5000 psi for filtration as fine as 10 mu—valves are rated up to 3000 psi. Dimensions and pressure drop charts are included.

Circle 480 on Page 19

Flexible Cushion Coupling

Dodge Mfg. Corp., Mishawaka, Ind.—12 page booklet—Flexible cushion couplings, designated Para-flex, are described in Bulletin A669B. The coupling is designed with a flexing body that automatically compensates for all combinations of misalignment and end float, and absorbs torsional vibration. Tables list selection data, service factors, and coupling size.

Circle 481 on Page 19

Magnetic Recording Tape

Film Dept., E. I. DuPont De Nemours & Co., Wilmington, Del.—12 page booklet—Bulletin A 11076 describes the results of a study on the base material's (of oxide coating) contribution to reliability in magnetic recording tape performance used for instrumentation purposes. Details of an analysis of film properties to tape performance characteristics are given and charts compare tape properties gage for gage.

Circle 482 on Page 19

Can Sorters & Uncasers

Atkron Inc., Bath & Graham Roads, P. O Box 311, Cuyahoga Falls, Ohio—8 page bulletin—Can sorters and uncasers described will automatically uncase, align, and orient for filling almost every type of can whether it is received in reshipper cartons, shipper trays, bags, or bulk. Principle of operation is covered and it is explained how the machinery is adaptable to a plant layout. The different models are illustrated, as are other automatic materials handling equipment.

Circle 483 on Page 19

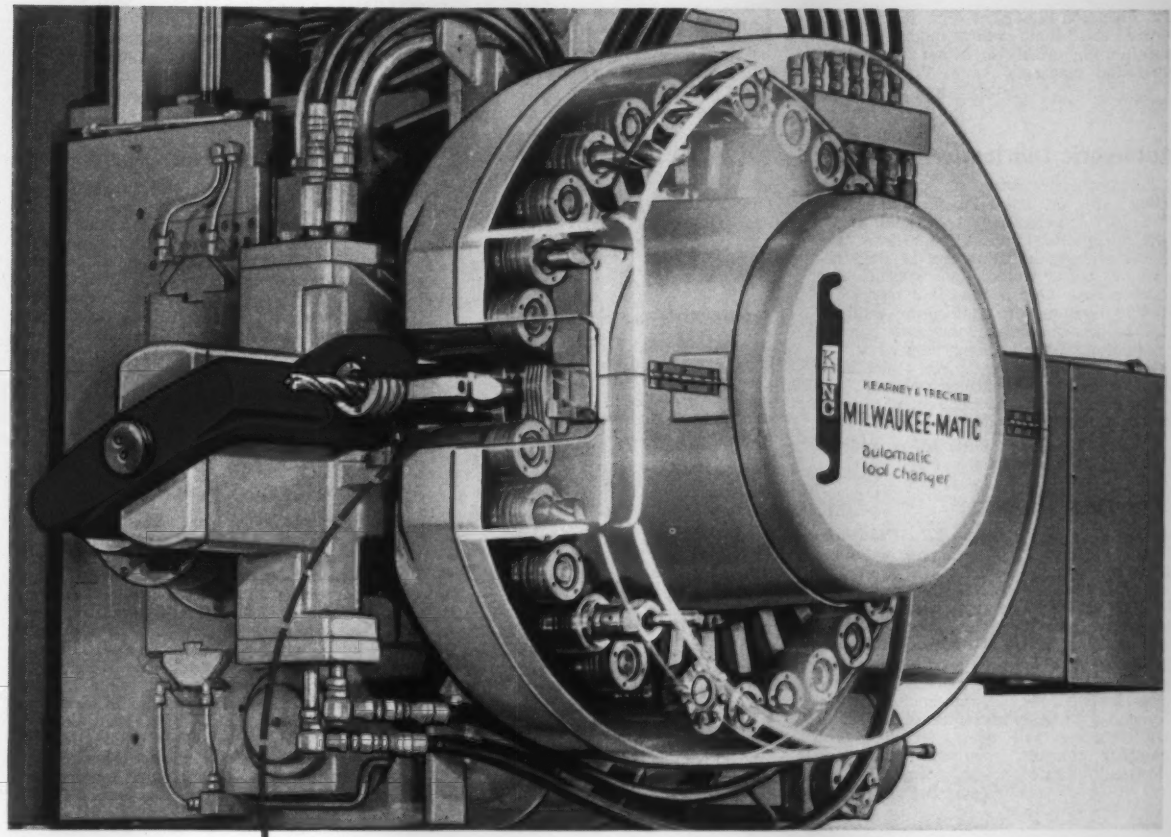
Special Drilling Machine

Micro-Path Inc., Subsidiary, Topp Industries, 4949 W. 104th St., Inglewood 2, Calif.—4 page pamphlet—Two printed circuit board drilling machines (automatic and manual) are outlined in Bulletin CDG-9572. Operation of the automatic unit with magnetic tape control is explained, aided by photos. Specifications for both machines are listed.

Circle 484 on Page 19

Miniature Indicator Lights

Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.—8 page bulletin—Miniature indicator lights suitable for use in data-processing equipment, computers, and automatic machinery are described in Bulletin L-160A. Data are given on two basic styles—one with built-in lamps which are not replaceable and one with replaceable lamp cartridges. Notes are



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Circle 716 on Page 19

also given on a typical data strip which consists of 10 lamp holders mounted on an aluminum channel for either vertical or horizontal reading.

Circle 485 on Page 19

Automatic Lubrication

Lincoln Engineering Co., 4010 Goodfellow Ave., St. Louis 20, Mo.—"Lubrication for Automation" is title of folder which contains reprints of articles and a collection of bulletins and catalogs describing power lubrication systems and components. One booklet is a report discussing how modern lubrication methods can reduce operating costs and improve production. Applications described in other bulletins cover metal processing, metal working, petroleum, printing, textile, food, paper, mining, chemical, and material handling industries.

Circle 486 on Page 19

Vibrating Screens

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—48 *page catalog*—Data are contained in Book 2777 on line of vibrating screens (12 different types in 212 sizes). The types of screens and shakeouts and how they meet screening and shakeout needs of different industries is discussed. Cutaway photos show construction features; other photos show various installations. Also included are: Screen cloth recommendations, and data on bouncing ball decks, snubbing and plugging controls, repulping decks, and electrically heated screen cloths.

Circle 487 on Page 19

Control Valves

Conoflow Corp., Dept. D-8, 2100 Arch St., Philadelphia 3, Pa.—16 *page booklet*—The application of valves and other control equipment in pulp and paper making processes is discussed in Bulletin MD-1. Schematic drawings show valve applications in such processes as sulfite acid preparation, blow tank heat recovery, brown stock washing, and black liquor evaporation. Also listed is a glossary of terms used in the pulp and paper industry.

Circle 488 on Page 19

Adjustable-Speed Drives

Speed Variator Div., Cleveland Worm & Gear Co., 3300 E. 80th St., Cleveland 4, Ohio—8 *page bulletin*—Speed drives described in Bulletin K-250 provide both increase and decrease of output speed over a range up to 9:1 from a constant speed power source. Adjustable-speed and drive control problems are discussed and typical applications are explained, along with methods and types of remote and automatic control. Notes are given on variable speed bedplate assemblies.

Circle 489 on Page 19

Finishing Processes

Roto-Finish Co., 3700 Milham Rd., Kalamazoo, Mich.—30 *page catalog*—Various types of automatic finishing processes such as grinding, deburring, descaling, and polishing are described in Bulletin RF 5-59-5M. Five basic types of compounds are discussed, and it is explained how different combinations can be used for special applications. Also included are notes on how radii can be broken and the fatique resistance of metal parts strengthened through mass production finishing techniques.

Circle 490 on Page 19

Gamma Radiation Control

Ohmart Corp., 2236 Bogen St., Cincinnati 22, Ohio—6 *page pamphlet*—Operating principle, performance, and advantages of gamma radiation measuring systems for density or specific gravity and liquid level control are described in Bulletin 105-C. The gages in the system provide continuous, automatic control of parameters such as per cent solids in a slurry, interface passage in pipelines, level of liquid in vessels and towers, and the control of the output densities of evaporators, thickeners, and dryers.

Circle 491 on Page 19

Time Cycle Controllers

Electric Switch Corp., Subsidiary, Bernco Engineering Corp., 2320 S. Tibbs Ave., Indianapolis 41, Ind.—16 *page booklet*—Data are contained in Catalog 459 on cam and drum type controllers that automatically control and program machines and processes by the use of adjustable cams which actuate sealed mercury switches, opening and closing circuits in the required sequence and time interval. Descriptions of five motorized cam type controllers and two drum controllers are given. Also covered is optional equipment such as electromagnetic brake, overriding clutch, synchronous motors, and compound gear support assembly.

Circle 492 on Page 19

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Circle 717 on Page 19

Tape Perforator

Soroban Engineering Inc., Box 1717, Melbourne, Fla.—12 *page booklet*—Subject of booklet is Model GP-2, a tape perforator with an operating speed of 240 to 300 characters per second. The problems associated with the high-speed recording of digital data in perforated paper tape are discussed and it is explained how this unit is designed to overcome the problems. Cutaway photos and dimensional drawings are included.

Circle 493 on Page 19

Cam-Operated Indexing Units

Standard Tool & Mfg. Co., 237 Laurel Ave., Kearny, N. J.—20 *page booklet*—Model ST-A9A, a basic cam operated indexing and locking unit is described, as are the three different styles of the unit. Schematic drawings show tool and dial plates, drive mechanisms, mounting tables, and panels. Load rating tables list terms of production per hour for several sizes of dial plates at varying speeds, cams, and number of indexing positions.

Circle 494 on Page 19

Viscosity Control Equipment

Norcross Corp., 247 Newtonville Ave., Newton 58, Mass.—4 *page pamphlet*—Viscosity control equipment described in Bulletin V-1224 is designed for automatically adding solvent to correct for evaporation losses. Two methods of installation are discussed, accompanied by schematic diagrams. Another schematic dia-

gram shows how the equipment can record and control multiple tank applications. Principle of measuring viscosity is also explained.

Circle 495 on Page 19

Magnetic Heads

Electronics Div., J. B. Rea Co., 2202 Broadway, Santa Monica, Calif.—8 page bulletin—Precision, magnetic tape and drum heads, ranging from one to 64 channels are outlined. Different styles are illustrated and construction features noted. Graphs list performance characteristics.

Circle 496 on Page 19

Electronic Signaling Controller

Thermo Electric Co. Inc., Saddle Brook, N. J.—4 page pamphlet—Subject of Bulletin 51 is Model 80025, a two position signaling controller that can be used with any transducer that generates a dc signal, such as thermocouples, tachometer generators, and load cells. Principle of operation is explained—pamphlet also includes a functional block diagram and dimensional drawing.

Circle 497 on Page 19

Centerless Grinder

Norton Co., Worcester 6, Mass.—16 page booklet—Straddle-bearing centerless grinder No. 2 is the subject of Catalog 1328. Features of the unit such as the straddle-bearing spindle and dual mobile wheel heads are explained, and photos show other features. Machine specifications and optional accessory equipment are listed.

Circle 498 on Page 19

Electromagnetic Controls

Automatic Switch Co., Florham Park, N. J.—data sheets—Bulletin 57-SAK contains new catalog sheets on electromagnetic controls for Catalog 57-S. Items described in the sheets include ac relays, long life solenoids, automatic engine starting controls, automatic battery chargers, break glass switches, differential relays, and remote control switches.

Circle 499 on Page 19

Infrared Heating Units

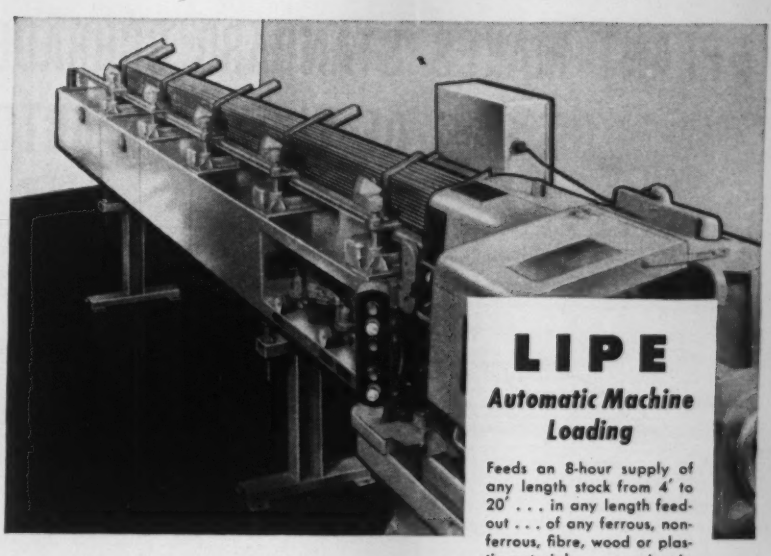
Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.—8 page bulletin—Line of infrared heaters and controls described in Catalog G-62 is applicable for drying, curing, and baking of plastic, textiles, paper and inks, ceramic products, and for metal preheating work. Wiring, installation, and construction photos are shown.

Circle 500 on Page 19

Time & Event Recorders

American Data Div., American Electronics Inc., 75 Front St., Brooklyn 1, N. Y.—4 page pamphlet—Data are given on line of modular time and event recorders capable of handling the outputs of high-speed reduction from the simplest to the most complex system data. The variety of speeds, types of inputs, outputs, and time indications are noted.

Circle 501 on Page 19



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PIONEERS IN PNEUMATIC BAR-FEEDING

Circle 718 on Page 19

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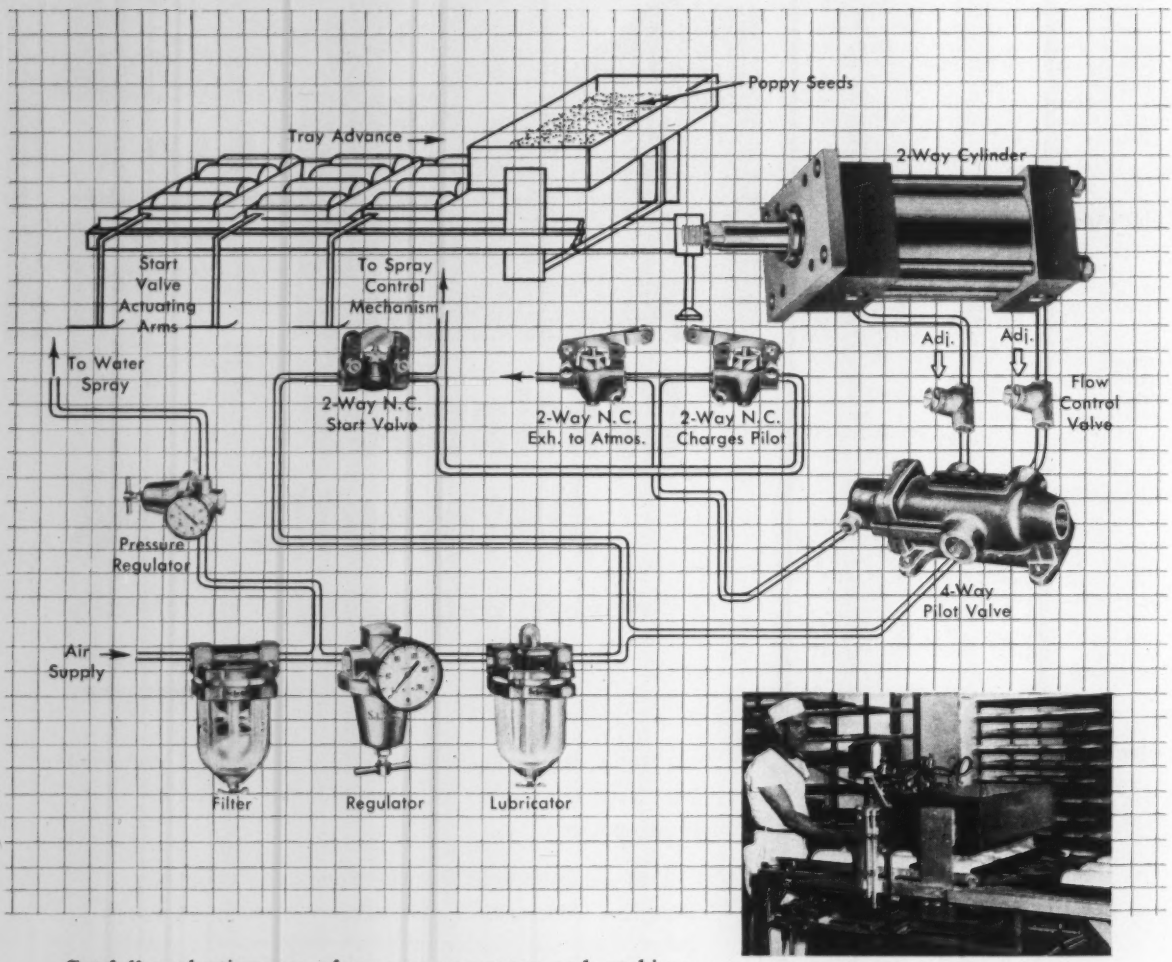

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AUTOMATION abstracts

SERVO POSITIONING CONTROL PRODUCES MATCHED PARTS

By FRED H. LONDON
Airborne Instruments Laboratory
Div., Cutler-Hammer Inc.
Mineola, N. Y.

MODERN METHODS of mass production require that machined parts be held to close tolerances for ease of interchangeability in assembly. However, occasionally a machine in a production line will not be able to produce parts within the necessary tolerances, and it may not be feasible or practical to replace this machine within a reasonable time. As a result, either the production line will produce a large number of rejects, or selective assembly will be required.

As a solution to these problems, it is possible to first complete machining of a part in the machine tool that produces out-of-tolerance parts, and then use the finished dimensions of these parts to control the machining of their mating parts. To do this, the wide-tolerance part is brought to a gaging station where it is automatically and accurately gaged. The gage dimensions are then used as reference signals in a closed-loop positional servo system which controls the cutting tool that produces the mating part.

In general, the gaging and machine tool setup operation will not appreciably increase the manufacturing time of a production line as a whole. However, it is necessary to co-ordinate operations so that after the critical machining operation is completed, the two mating parts will move together through the rest of the operations to their assembly point.

A manufacturing procedure of this type is used in an automated railroad car wheel and axle shop. In this shop, old axles and wheels are reconditioned and new ones are machined and bored. In the final operation the wheels are pressed on the axles ready for mounting on railroad cars. All manufacturing operations in the shop—including machining, transferring, and pressing the wheels on the axles—are done automatically. Only inspection is performed manually.

The axles are first conveyed to any of a number of lathes. Here they are gaged, turned down a certain amount, burnished, and inspected. As an axle is moved to a gaging station, a pair of wheels is moved to two vertical boring mills, *Fig.* 1.

At the axle gaging station, gaging heads measure the diameters of the axle seats for left and right hand wheels and produce reference signals for relay servo systems associated with each wheel boring mill. These servo systems automatically position the boring tools which bore the railroad wheels for press fits on their respective axle seats.

The total linear range of the gaging transducers used in a servo system is 1 inch, and the positioning accuracy is within 0.0005 inch. The load on the servomotor is a precision-machined wedge, driven through a gear reducer by means of a ball screw. After the wedge is positioned, a stop to which a boring bar is attached is hydraulically clamped to the wedge for the cutting operation. For this application, an additional input to each servo has been provided that makes it possible to compensate for tool wear or change of the press fit by means of an adjustment on a master control panel.

Servo System Design

A block diagram of the positioning servo system used to position the boring tool for each wheel is shown in *Fig.* 2. An oscillator excites the gage heads, which act as linear-motion transducers. Other electronic components of the system are an ac amplifier with a phase-sensitive detector, a stabilizing network, and a dc amplifier.

The gaging transducer output voltages (reference signal and feedback signal) are differentially con-

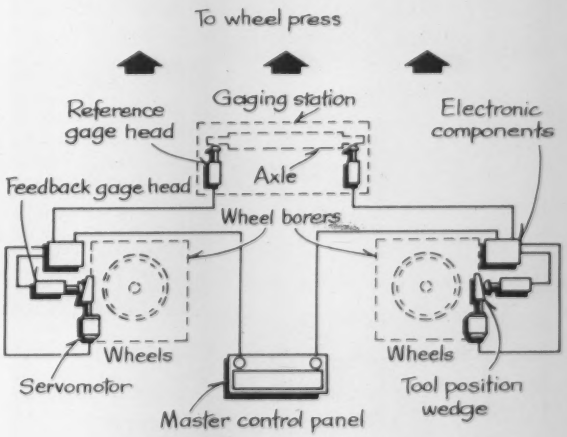


Fig. 1—Turned axle seat diameters are gaged electronically to provide reference signals to servo positioning systems associated with wheel boring machines. Servo systems automatically position boring tools so that bored wheels will press fit to their respective axle seats.

nected to the input of the ac amplifier. To ensure stable operating characteristics, feedback is used in this amplifier. The output from the amplifier is changed from ac to dc by means of a synchronous demodulator. This phase-sensitive detector uses the same oscillator that provides the excitation voltage for the linear variable differential transformers. This ensures that small variations in frequency will not affect the operation of the servo.

The output from the detector goes through stabilizing networks into a dc amplifier. All stages of the dc amplifier are of the differential type designed to keep drift to a negligible minimum. The output of the dc amplifier operates relays which act as power amplifiers for the 60 cps, two phase servomotor that positions the cutting tool.

The linear differential transformer which provides the reference signal for the servo is mounted as a gaging head in the gaging station. In order to admit the part that has to be gaged, and which will then act as a reference for the servo system, the gaging station has to be opened wide. In almost all cases, this will cause saturation of the servo system. Because of unavoidable lead or lead-lag networks, saturation will cause sharp peaks in the forcing function. This could make the system sluggish and often cause large overshoots. Also, saturation is detrimental to the dc amplifier and might result in destructive grid currents.

In order to avoid the problems created by saturation, the servo system was designed so that the only subsystem that will saturate with excess error signal

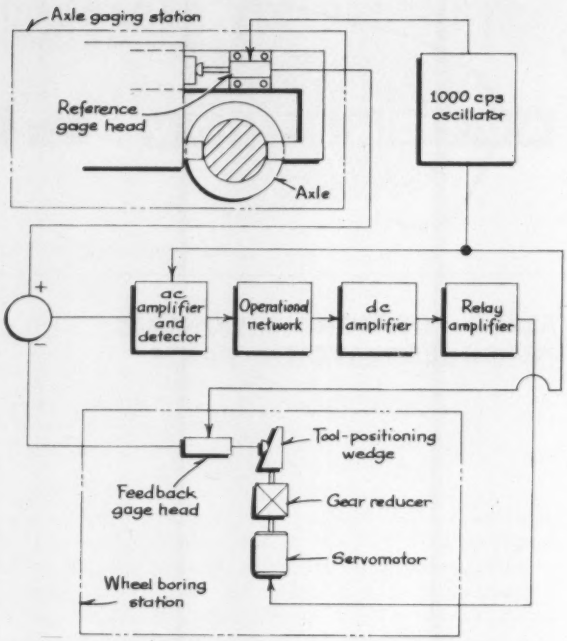
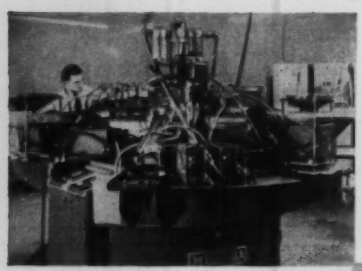
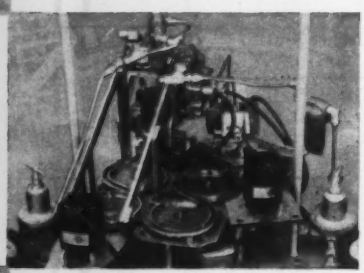


Fig. 2—Block diagram illustrates components used in servo positioning system for one wheel boring mill. System adjusts precision boring operation to produce holes in wheels that mate with turned axles.





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is the ac amplifier. Except for some minor gain changes, the ac amplifier will not be affected by saturation. At excess error signal, the amplifier output will be the limiting voltage. All other subsystems follow the ac amplifier, and they are designed to operate linearly for the limiting voltage. Hence the ac amplifier will limit the error signal until it has dropped within the linear range of the over-all servo system.

A relay amplifier system was chosen instead of a linear power amplifier because of the saving in weight, cost, and space. Its performance was found to be highly reliable. Because theoretical analysis for this type of system is more complex than for linear systems, a fairly large number of trial-and-error adjustments had to be made in the final design stages. However, in the end, the system performed reliably and accurately.

From a paper entitled "A Positioning Servo for Automatic Machine Tool Operation" sponsored by the Detroit Section of the IRE for presentation at the 7th Annual AIEE-IRE Conference on Industrial Electronics, Detroit, Sept. 1958.

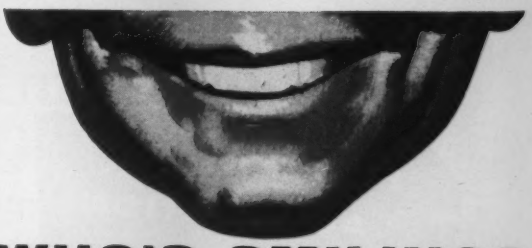
TYPES AND SELECTION OF PNEUMATIC CONVEYING SYSTEMS

CONVEYING of granular and powdered solids in bulk by air power instead of manpower is becoming increasingly important to the process industries. Some of the benefits of pneumatic conveying are: Faster and more flexible handling, greater cleanliness, increased safety, and reduced labor. In spite of the large amount of work being done in this field, however, the design of complete systems still leans heavily on "seat of the pants" engineering. Judgment and experience play a major role in the specification and selection of the proper components.

When considering an air conveying system two choices are available. A negative pressure or a positive pressure system may be selected. The nature of the usual conveying problem automatically suggests which system will give the better results. But for many installations, the choice is not so easy. As a general rule it can be stated that when it is necessary to convey from several points to one point the negative pressure system is preferable, and when it is desirable to convey from one point to many different points, the positive pressure system should be selected.

Negative Pressure Systems

In the negative pressure type of system a centrifugal fan, rotary positive-displacement blower, or other vacuum-producing exhauster unit is situated at some distance from the solids pick-up point. A separating unit, such as a cyclone collector, is placed between the pick-up point and the exhauster. Solid material is separated from the air stream by the collector, hence never passes through the fan. When conveying is done under suction, any leakage which might occur is inward. This means that there is no loss of material



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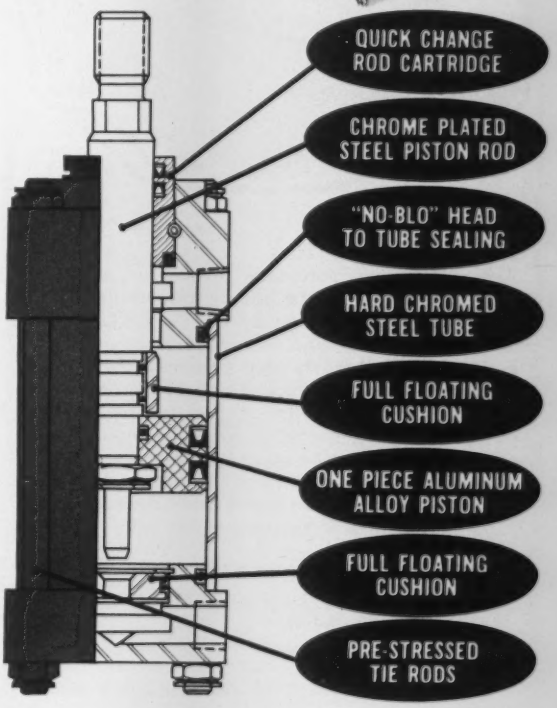
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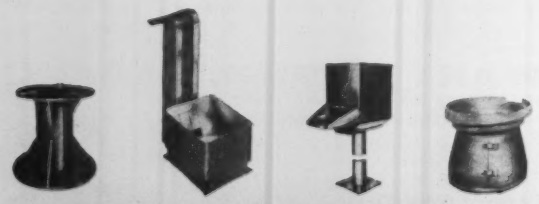

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and no dust in the atmosphere. Both negative and positive pressure systems have a minimum of moving parts in the vicinity of the operator—thereby reducing the risk of personal injury.

A typical negative conveying system is shown in *Fig.* 1. Discharge from the storage bins passes into the air intake line. Airlocks may be used, but are not always necessary at the intake of a negative system. In many cases, material may enter by gravity.

Suction created by fan or a rotary positive-displacement blower carries the material to a cyclone collector. As the material passes into the collector, the solid particles drop to the base of the unit and are fed by an airlock valve into a storage bin. Dust which is entrained in the air system may be separated from the exhaust air by a filter on the discharge side of the fan. Solid particles removed may be recovered.

Positive Pressure Systems

A typical positive pressure conveying system is shown in *Fig.* 2. In this type of system the source of air flow is located at the head of the line and the air pushes rather than pulls solids through the ducts. In a positive pressure system, the material must be introduced into the air stream through an airlock or a choke screw feeder. The rest of the physical equipment arrangement is similar to that described for the negative pressure system. In a positive pressure system, relatively low volumes of free air will move large quantities of material. Because of this the cyclone separator can often be eliminated in this type of system.

Several features should be looked for in selecting components for pneumatic systems. Among these are:

1. *The Fan.* The fan used in a negative pressure system should be a high-speed, centrifugal unit to

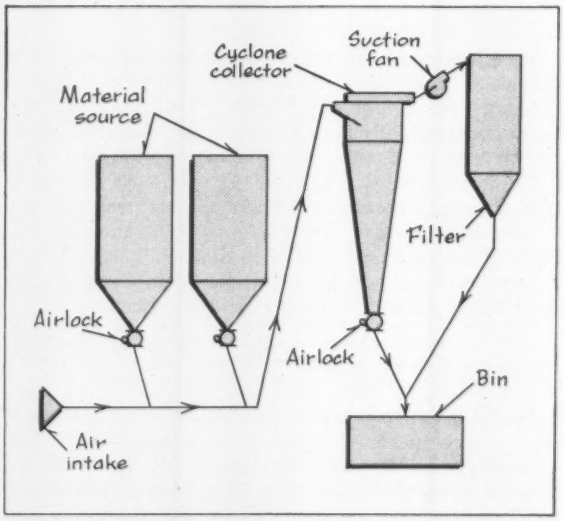

Fig. 1—Flow of air and material in negative pressure conveying system is induced by exhauster at discharge end. Negative pressure systems are commonly used to convey materials from several points to a single collection point.

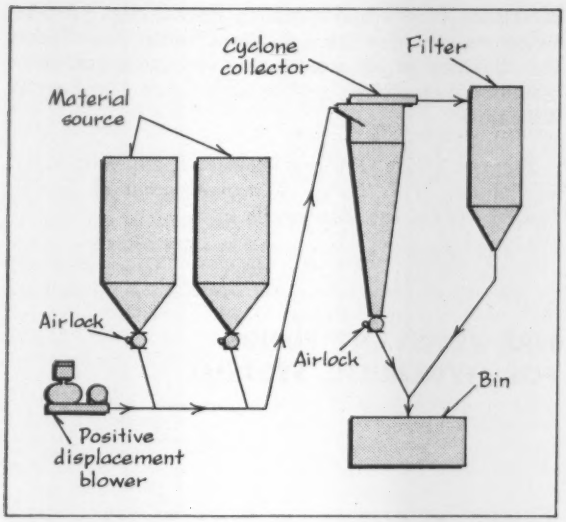

Fig. 2—Positive pressure systems have the source of air flow at their head ends. Material must be introduced to the air stream by force. Large quantities of material may be moved with relatively low air volumes with this type of system.

provide the relatively high static pressures required. It is important that it be balanced for quiet and efficient operation.

2. *The Collector.* The design of a collector is important for peak efficiency. Smooth interior surfaces are vital to good performance. Proper sizing of entrance transition, cone, and cylinder are critical. Where the application requires the handling of an abrasive material, a replaceable wear-resistant lining should be specified. A tightly sealed, easily removed inspection door should be incorporated in the design.

3. *Rotary Airlock.* Precision machining and rugged construction should be sought. Outboard antifriction bearings will minimize or eliminate bearing failure or contamination of product by lubricants. A full-length, removable inspection and cleanout panel should be included. The rotor should fit to the body with close tolerances. Proper sizing of the unit for the product to be handled is vital.

4. *Conveyor Piping.* For most applications, piping should be of heavy gage carbon steel with sections connected by gasketed compression-type units to ensure a tight system throughout. Not only does this add to the efficiency of the conveying system, but it reduces hazards when handling poisonous, toxic, or flammable material. Long-radius elbows should be specified. Where abrasion is a problem, built-up elbows with heavy cross sections should be incorporated.

5. *Series Filter.* In some cases, to avoid loss of valuable material as well as the passage of material to atmosphere, the use of a return air line and a series filter is recommended. Where a return line is not advisable, dust loss can be eliminated through the use of a multiple-tube dust collector at the fan discharge.

6. *Engineering.* Pneumatic conveying systems still hinge on the empirical approach, and judgment and

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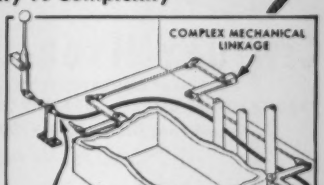

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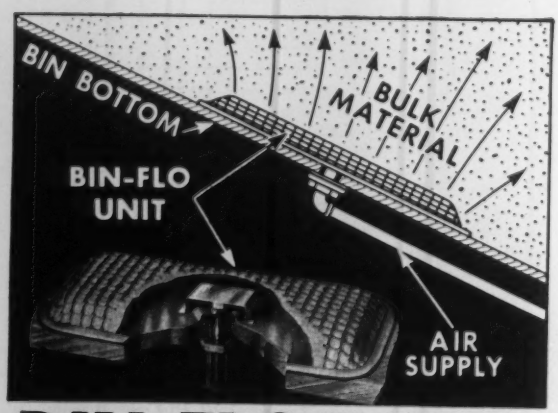

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experience play a major role in their design. An inferior system may have a lower initial installation cost, but can be far more expensive in terms of costly operation, excessive maintenance, and production difficulties.

From an article "Pneumatic Systems" which appeared in Pointers, Vol. 2, No. 4, a publication of Sprout, Waldron & Co. Inc., Muncy, Pa.

FIRE RESISTANT FLUIDS FOR HYDRAULIC SYSTEMS

By RICHARD L. LESLIE
Supervisor, Fluid Laboratories
Vickers Inc.
Detroit, Mich.

THE DECISION to use a less flammable type of fluid is usually arrived at after a study which weighs the factors involved, including the machine operation, the operation of surrounding machines, and the work locations of personnel. Selection of a particular fire resistant fluid depends upon several technical and economic considerations.

Technical Factors

There are three general types of fire resistant fluids —synthetic, water-glycol, and petroleum oil-water emulsions. Each type is available in several formulations. Performance of a given fluid depends upon its chemical and physical properties established by its formulation. It is possible that a number of fluids may appear in laboratory measurements to have nearly identical properties, yet behave quite differently in a hydraulic system. Major technical criteria for selecting fire resistant fluids are:

1. **Fire Resistance.** Presently marketed fire resistant fluids will burn. Hence, they cannot be classified as nonflammable. However, they are less flammable than petroleum oils and offer some protection from fire.

The great variety of testing procedures and interpretations of test data have caused some confusion as to the true fire resistance of hydraulic fluids. However, it has been established that practically all of the fire resistant fluids on the market offer reasonable protection against ignition in the event of hydraulic line failure. A precaution is in order, however, in the case of "snuffer" type fluids that are formulated with water. These fluids gain their fire resistance from their water content. As water is lost through evaporation, they become easier to ignite. Therefore, laboratory control of water content is essential to maintain fire resistance.

2. **Compatibility with System Component Materials.** Current fire resistant fluid formulations do not present major problems in compatibility with the materials used in the components of hydraulic systems, since their use was contemplated in hydraulic systems designed originally for petroleum oils. However, some consideration may have to be given the choice of elastomeric seals for some types of fluids. Although Teflon seal material is unaffected by any of the hydraulic fluids used within their temperature ratings, use of this material may be restricted by its cold flow properties and limited elasticity.

Fire resistant fluids have presented the problem of rusting of

reservoirs above the liquid level, particularly when fluids with water content are used. Painting of the interior of the reservoir has not proved a successful means of preventing rust, especially for long service where operating temperatures are higher than normal. The ideal way to prevent rust is to use stainless steel for the interior walls of a reservoir. Stainless clad steels can be used advantageously for structural members. The initial cost of such a reservoir is somewhat higher, but the long-run benefits of troublefree operation and adaptability to any type of fluid are realized.

Fire resistant fluids containing water should not be used in installations where the hydraulic fluid is also used to lubricate the bearings in machinery, particularly where the bearings are not completely filled. This is especially important where antifriction bearings are used, since these elements are sensitive to rusting of their portions not immersed in the fluid.

3. Operating Characteristics of the System. Operating temperature, pressure, and system response are important considerations for successful operation of a hydraulic system. Such factors must be related to the characteristics of the fluid in the system.

The fluid chosen must have a usable viscosity within the operating temperature range of the system. Our experience indicates that the maximum recommended viscosity for startup of pumps be 4000 SSU. Viscosities higher than this impose considerable hardship on pumping units at startup. However, for satisfactory continuous system operation, the viscosity should have a lower value. Generally, this should be not less than 70 SSU.

Fluid stability also limits maximum operating temperatures. Fluids containing water should generally be limited to system operating temperatures below 150 F to prevent excessive water evaporation. Otherwise, closer than normal laboratory control of water content must be maintained.

Synthetic types of fire resistant fluids should be operated within the temperature ranges recommended by manufacturers. In general, these fluids are not intended for operation at extremely high temperatures. Exposure of hydraulic lines to high temperature areas should be avoided to prevent thermal breakdown of these fluids.

The importance of proper pump inlet conditions cannot be over-emphasized. Since fire resistant fluids have higher specific gravities than petroleum oils, the static lifts of fluids to the pump should be considered carefully. Pressure drops due to flow through strainers and suction lines should also be minimized to prevent cavitation in the pump. To avoid such head losses, the sizes of strainers and lines should be proportioned in relation to fluid viscosity. Leakage of air into the suction line should also be avoided, since entrained air adds to the cavitation problem.

4. System Leakage Rate. Excessive system leakage, rather than performance, may be the controlling factor in selecting a hydraulic fluid on the basis of price. It is possible to construct and maintain systems that have little or no leakage. However, such systems usually have higher first costs due to the type and quality of fittings, seals, etc. that are used. On the other hand, the higher price may be justified through reduced maintenance, improved safety, and better housekeeping. Because of the appreciable differences in the selling prices of fire resistant fluids, the cost of make-up fluid for a leaking hydraulic system may be a major consideration in the over-all cost picture.

5. Lubricating Properties. Ability of a hydraulic fluid to reduce friction and wear of mating moving parts is an essential characteristic of a good fluid. Low friction values do not necessarily ensure low wear rates, but both characteristics are desirable.

Excessive friction is particularly noticeable in the operation of spool valves and linear actuators, resulting in slow machine

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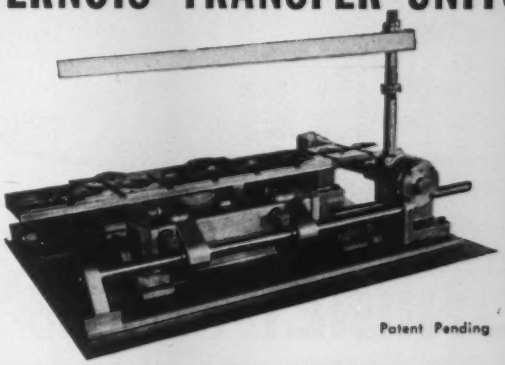

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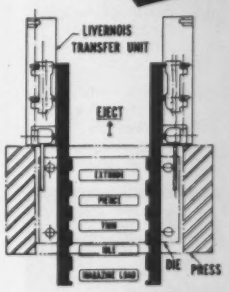

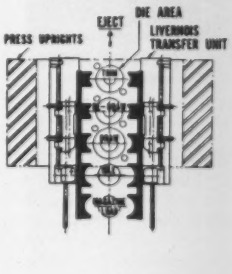

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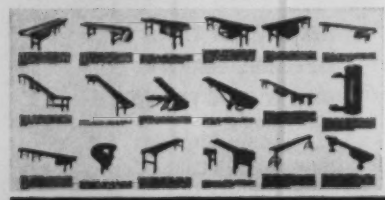

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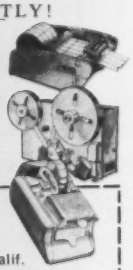

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Circle 728 on Page 19

response. Friction in valves may be particularly apparent where suspended dirt particles are present. These particles may wedge between the valve spools and bodies, increasing friction to very high values. This problem is most important where electromechanical servo valves are used, as on numerically programmed machine tools. Good filtration, combined with proper component manufacturing techniques, has resulted in good control of the dirt problem and hence reliable operation of servo systems. Except for petroleum oil-water emulsion type fluids, fire resistant fluids can be filtered to a degree that is considered satisfactory for servo valve operation.

Wear and pump life, and their relation to the lubricating properties of a hydraulic fluid, are difficult to evaluate. Laboratory bench tests have had very little success in correlating actual pump wear rates with the lubricating values of various fire resistant fluids.

Industry field tests, using hydraulic pumps as wear testing devices, have shown differences in pump wear rates with different fluids. However, attempts to draw broad, general conclusions from these tests would be hazardous. For one thing, these tests should be considered valid guides only when the types and sizes of pumps tested, and operating conditions, are the same.

An often asked question is: "How is pump life affected when a fire resistant fluid is compared to a petroleum oil?" We have seen test results where only two petroleum oils were compared and they showed a spread of from two to four times in pump life. As for comparisons of fire resistant fluids with each other, recent field experience showed pump life extended from 50 to 100 times by changing from one brand of fluid to another. Both fluids were of the same type, and laboratory examinations showed that they had similar physical properties and met the same specification.

Much of the available literature on pump life is based on tests using small vane pumps. Wear rates of larger pumps or different types of pumps are often markedly different. Axial piston pumps, for example, are less sensitive to sliding type wear. Their longevity depends mostly on that of their anti-friction bearings, hence is determined largely by the ability of the fluid to lubricate the bearings.

Economic Considerations

Several economic factors usually enter the decision to use a fire resistant hydraulic fluid:

1. **Savings in Fire Insurance.** If savings in the cost of fire insurance is the major factor in selecting a fire resistant fluid, the underwriters should be consulted on the effect of various fluids on insurance rates. Although there is still some confusion in rating fluids for underwriting purposes, clarification is expected in the near future.

2. **Savings in Property Protection.** With reduced fire hazard, there is less danger of extensive property damage resulting from hydraulic line failures.

3. **Increased Cost of Fluid.** Fire resistant hydraulic fluids cost more than petroleum oil fluids. Excessive leakage in the hydraulic system can aggravate the cost problem by requiring large amounts of make-up oil.

4. **Increased Cost of Maintenance.** Laboratory testing, especially of water type fluids; greater need to control system leakage; and more frequent filter changes may increase maintenance cost with fire resistant fluids.

From a paper entitled "Managements' Considerations in the Selection of Fire Resistant Fluids" presented at the Vickers Inc. Fabricating Machinery Conference, Detroit, April 1959.

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

Case 1857-P

TUBE TESTING

. . . We wish to enlist your aid in the solution of a problem. Our requirements are for an automatic unit to test steel tubing at 500 psi air pressure under water. Tubing diameters will be ¼, 5/16, ⅜, ½, ¾, and 1 inch; walls will vary from 0.026 to 0.060 inch in thickness; lengths will vary from 36 inches to 30 feet. End seals or chucks will have to accommodate tubing ends as made by a flying type cutoff shear on a Yoder type electric weld tube mill. Information on any segment or component will be appreciated . . .

Supervisor of Engineering

Case 1867-P

COUNTING DRAPERY HOOKS

. . . We wish to feed and escape 14 drapery hooks at a time into a polyethylene bag or envelope. We have purchased a 20-inch vibratory feeder which orients the hooks. Our production people are demanding an absolutely perfect release count of 14 pieces. We believe this to be an impossibility with a linear displacement escapement due to the hooks not being, in all cases, formed in a flat plane. We would appreciate any and all suggestions. . .

Chief Engineer

Case 1874-P

MOP ASSEMBLY

. . . Problem: How to attach a hank of roving yarn to a wooden handle, in a permanent manner, to produce a mop. Handle is pine, approximately 15/16-inch diameter by 48 inches long. Mop head consists of 64 strands of yarn 28 inches long, looped to provide 128 ends. The yarn, as received from the supplier, is in coils of approximately 300-foot length, the coil being made up of 64 strands 300 feet long. We have been attempting to find wire winding equipment, stitching or stapling device, or hog ring clamping unit that may be applied automatically or semiautomatically to this assembly problem . . .

Consulting Engineer

Case 1883-P

TUBING CUTOFF CONTROL

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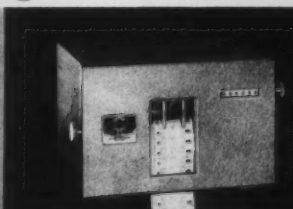

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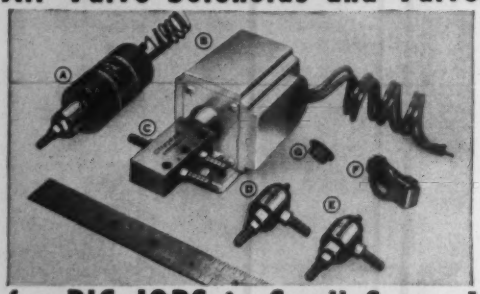

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Circle 732 on Page 19

want to position and cut off automatically. We will be cutting these tubes into various lengths. The setup and automatic adjustment of a stop, or stops, is to be power operated with a tolerance for any given length to be plus or minus 1/32 inch over the 40-foot range. This unit will be integrated with conveyors, tube cutoff, and end facing machines . . .

Boiler Manufacturer

Case 1891-P

WEB REGISTRATION

. . . We are interested in using a magnetic pickup to detect a small metal staple, a magnetic spot of tape, or a magnetic spot of ink on the edge of our fabric as it enters our processing equipment at 60 yards per minute. These spots would be spaced at 5-yard intervals, and we would like to detect their locations within ½ inch. Can you give me information on magnetic pickups, tape, or ink. . .

Chief Industrial Engineer

SUGGESTIONS FOR 1673-P (JAN. 1959)

HARDNESS TESTING

. . . We assume from your reader's comments that the equipment shown in the attached Bulletin RH-12-58 may be applicable. We will be pleased to work with your reader. . .

T. M. Broughton
American Machine and Metals Inc.

. . . I am sending you an application data sheet on Micro-Hardness Tester Instruments which may be a solution to your problem. . .

Harry R. Jackson
Sheffield Corp.

SUGGESTION FOR 1773-P (April 1959)

MOTION CONTROL FROM FILM

. . . We can give you a record playback on film, but how much motion, what rate of tilting, and when do you want it to move. . .

John Obenski

SUGGESTION FOR 1822-P (May 1959)

CLOSURE FEEDING

. . . Attached is our brochure showing a multiple track unit. Any number of tracks up to approximately twelve can be supplied. We would be interested in seeing parts to be fed and learning more of your problem. . .

A. W. Renfrew
Haberstump-Harris Inc.

SUGGESTIONS FOR 1824-P (May 1959)

SHEET GAGING

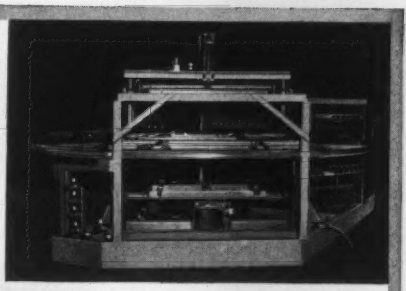
. . . We are in a position to solve this gaging problem providing we can do it either in strip form or on individual sheets. We manufacture several types of thickness gages including x-ray, beta ray, and contact. . .

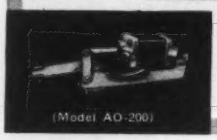
W. C. Mullin
Pratt & Whitney Co. Inc.

. . . The type of equipment which your reader desires for measuring sheet metal ranging from ¼ inch to 16 gage would be of interest to us. Application of some of our standard equipment with a few variations could be applied to this problem. . .

E. M. Armstrong
RCA Industrial and Machine Tool Operations
Radio Corp. of America

COOL IDEA

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Circle 733 on Page 19

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Circle 735 on Page 19

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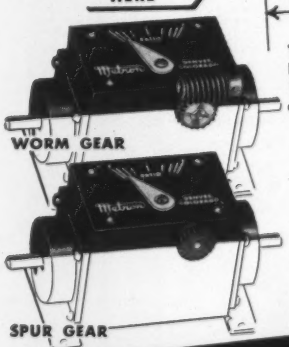

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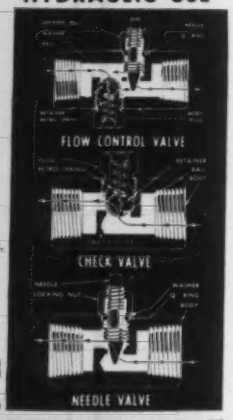

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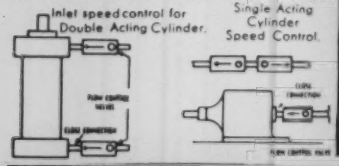

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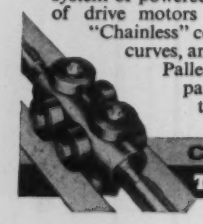

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Report covers, in detail, considerations involved in the physical installation of electronic data processing equipment. Organization and management of an installation program, as well as physical factors requiring routine and special attention, are discussed. Costs and experiences in several installations are recorded.

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By Orville T. Barnett, assistant manager, metals research division, Armour Research Foundation; 244 pages, 6 by 9 inches, illustrated, published by Reinhold Publishing Corp., New York; available from AUTOMATION; *$7.00 postpaid.*

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Industrial Publication

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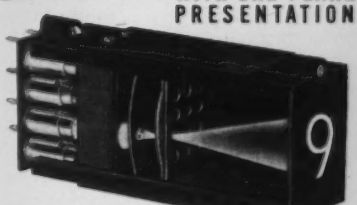

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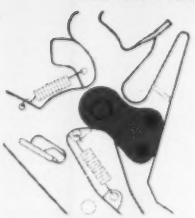
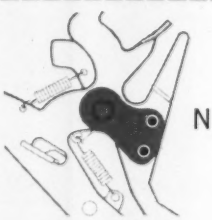


OLD

Two operators assembled 2 solid rivets and 1 shouldered stud into countersunk holes of trip pawl, placed this on a tray, then placed carrier arm over stud. Third operator positioned bearing plate over rivets and stud, lifted the loose assembly from the tray and slid it under a staking machine to stake the 2 rivets.



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The countersink is eliminated, in all three locations. On the special TRS sliding fixture, each operator assembles all components over 2 locating pins, with the stud in place. The loaded fixture is then slid into riveting position, and the riveter is actuated by a foot lever to fasten the assembly with 2 semi-tubular rivets.

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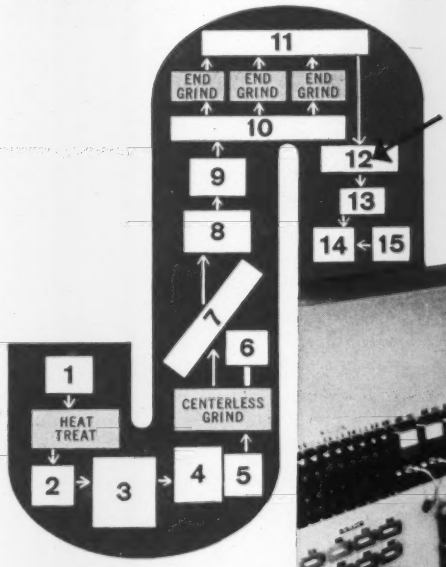

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RCA Electronic Piston Inspection Machine in operation at a major Midwestern automotive plant.

Flow diagram showing typical applications of RCA AUTOMATION

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11. RCA Conveyor
12. RCA Final Inspection Machine
13. RCA Non-Mar Feeder
14. RCA Automatic Assembly Machine
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PISTON INSPECTION MACHINE
checks: OD of piston
ID of pin hole
Taper of skirt
13 segregations
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PISTON PIN INSPECTION MACHINE
checks: Length
OD runout (cloverleaf)
OD Taper
11 segregations
count

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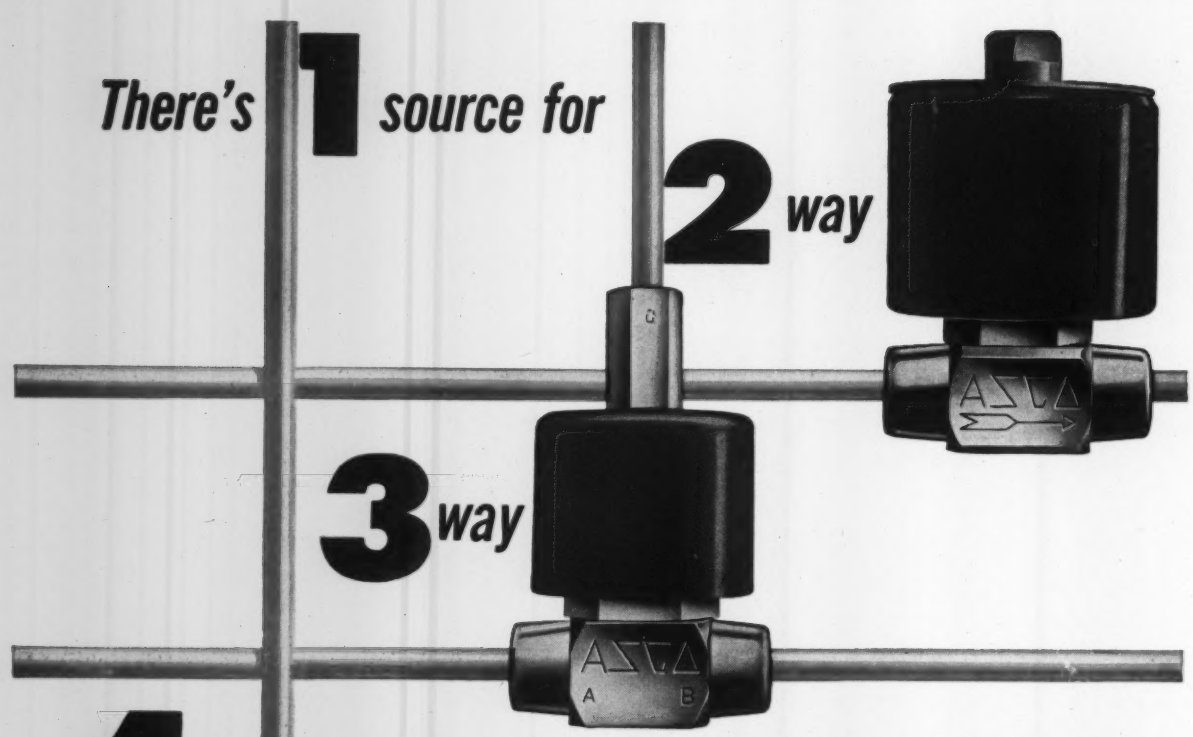

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